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HDL-TR-1610

RADIO-WAVE PROPAGATION MEASUREMENTS OVER SEA WATER

by

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August 1972

U.S. ARMY MATERIEL COMMAND

HARRY DIAMOND LABORATORIES

WASHINGTON, D.C. 20438

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Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY *(Corporate author)* Harry Diamond Laboratories Washington, D.C. 20438	2a. REPORT SECURITY CLASSIFICATION Unclassified
	2b. GROUP

3. REPORT TITLE

RADIO-WAVE PROPAGATION MEASUREMENTS OVER SEA WATER

4. DESCRIPTIVE NOTES *(Type of report and inclusive dates)*

5. AUTHOR(S) *(First name, middle initial, last name)*

M.M. Algor

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
August 1972	~~104~~ 98	1

8a. CONTRACT OR GRANT NO.	9a. ORIGINATOR'S REPORT NUMBER(S) HDL-TR-1610
b. PROJECT NO.	
c. AMCMS Code: 5910.22.63353	9b. OTHER REPORT NO(S) *(Any other numbers that may be assigned this report)*
d. HDL Proj: 11612	

10. DISTRIBUTION STATEMENT

Approved for public release; distribution unlimited.

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY
	U.S. Army Materiel Command

13. ABSTRACT

Propagation loss was measured at three frequencies (30, 140, and 412 MHz) over various sea-water paths out to 40 nautical miles between a moderately elevated shore-based receiving site and a floating transmitter platform essentially at the water's surface and subject to wave motion.

The measured losses agreed well with theory, assuming a "standard atmosphere" for the test conditions. Certain anomalies and ocean-wave effects were noted. In general, meteorological conditions were relatively constant and "normal" for eastern Florida in summer.

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1. INTRODUCTION

This experiment was conducted in order to determine the frequency region most conducive to transhorizon communications over a sea-water path of about 20 to 50 nautical miles (naut mi), considering various practical factors. Unlike many investigations reported earlier, a special requirement of this study was that one terminal be floating essentially at the water surface, and that the other terminal have a limited elevation ranging between 50 and 100 ft.

Simple theory (see section 8, "BIBLIOGRAPHY") shows that the effective radio horizon for a 100-ft elevation is about 12 naut mi, whereas that for the surface terminal is much less, and may even vary in accordance with its location on the peak or trough of a wave. The literature includes little concerning propagation at low elevations in this "near-shadow" region between "line-of-sight" mobile applications and "deep-shadow" communications over hundreds of miles wherein high-power tropo-scatter fixed stations are commonly used. Accordingly, additional objectives were to (1) determine reasonable system parameters, (2) examine signal levels and fading characteristics at several frequencies and distances, and (3) identify the effects, if any, caused by ducting, surface-wave action, and other meteorological conditions within the available time limits of the field test.

2. SITE SELECTION

The arrangement considered most expedient for the experiment was that of using an existing shore-based radar facility as a receiving site in combination with a small, floating transmitter terminal. This transmitter would be serviced and moved to various distances by an attending vessel. Such a facility was located at Boca Raton, Florida, where a Navy-owned site overlooking the beach is operated by the Georgia Institute of Technology as an experimental radar test station. This site included such advantages as a tower structure on which receiving antennas could be mounted, a working radar system with which true ranges could be determined, electrical power, and other normal incidental facilities. Also, an available "work boat" was assured--a 45-ft commercial salvage vessel which had been chartered from time to time by the Georgia Institute of Technology to assist in radar studies. A contract was therefore arranged for Georgia Tech to supply facilities, the chartered work boat, incidental services, and radar

and meteorological data. Their engineering personnel arranged for installation on the tower of the several (government-furnished) antennas necessary for the propagation study.

Although some space for instrumentation was available in existing buildings at the test site, this space was not considered suitable for equipment survival because of high humidity and temperature in a salt-spray environment (only 100 to 200 ft from the surf). Use of an available air-conditioned 28-ft semi-trailer was considered desirable as a mobile laboratory, in which receiving and recording equipment, as well as associated test and calibration instruments, could be installed. The trailer, which was also used for packing and transporting delicate equipment to the test site, was moved to location by a commercial trucking firm. The controlled environment made possible by this arrangement was later considered almost a necessity for this locality.

3. FREQUENCY SELECTION

The frequency range of potential interest in this study is loosely bounded on the low end by increased power losses in the small (3 to 4 ft maximum height) antenna permitted on the floating terminal. At 30 MHz, for example, which was the arbitrarily assumed limit, an estimated one-half of the transmitter power was dissipated in the antenna loading coil. Below this frequency, additional system problems are also more likely to occur from long-distance sky-wave interference. The highest practical frequency is determined by the state-of-the-art in generating useful power from a small, reliable source, and by increasing propagation losses per mile (assuming no unusual ducting effects). This limit was again arbitrarily set at 1500 MHz. Four essentially clear-channel transmitting frequencies were assigned in this range for the experiment: 30.25, 140.25, 412.00, and 1220.00 MHz. An additional frequency at 36.20 MHz was permitted for a two-way communications link to assist in conducting the test.

It was originally intended to record transmissions at all four frequencies simultaneously in order to correlate fading. Technical problems in constructing the transmitter and receiving converter for 1220 MHz, however, made the use of this frequency impossible within existing time and budget limitations. Later operating difficulties made it possible to record only two of the remaining frequencies at any one time, although this inconvenience did not cause the loss of much practical data.

4. TRANSMITTING SYSTEM

Several crystal-controlled transmitters were constructed in individual water-tight boxes mounted on a common ground plane of light aluminum. The use of separately mounted vertical whip antennas made rechecking of power outputs and antenna impedances convenient. The whole assembly was secured to a 9-ft surf board for flotation, as shown in figures 1 and 2.

Originally the floating platform was self-powered by a regulated storage battery supply in a watertight case suspended by a "U" bracket underneath the assembly. The bracket also insured a good sea-water ground for the antennas. Unfortunately, this added about 120 lb (in air) to the platform weight and required the use of a sling and powered hoist for manipulating it over the side of the boat. Experience on a calm day showed this arrangement to be virtually uncontrollable and physically dangerous with even slight boat motion; it would be absolutely impossible in an appreciable sea. Field modifications therefore were made to relocate the battery supply aboard the attending boat, thus lightening the float to about 40 lb. The lesser weight and size made it possible to lift the platform manually over the side with acceptable safety, even in fairly heavy seas. The resulting transmitting system is shown in figure 3. Voltage drop was reduced in the connecting battery cable by using the insulated outer metal braid of RG58/U coaxial cable for each of a pair of conductors 250 ft long, attached at intervals to the tether rope. This presented something of a problem in unreeling and recovery, but a procedure was worked out. By limiting to two the number of transmitters in use at one time, the drop was kept to about 2 volts at 2 amperes average drain. Although the 250-ft tether distance was much less than that originally planned, this separation seemed adequate to minimize antenna/boat interaction, provided the boat was not directly in line with the transmission path. In records made while the platform was being transported to the boat's side to switch transmitters, no significant effect was noticed beyond 10 or 20 ft in this orientation. The extra voltage drop produced a terminal voltage at the transmitters close to their lower design limits, where output power began to change rapidly with voltage. Fortunately, the total test period during a day was small compared with the battery's useful life per charge of about 3 hr; a spare was available if needed. Thus, it was possible to measure rf power outputs under known voltage conditions with reasonable assurance that the readings would remain the same throughout a series of tests.

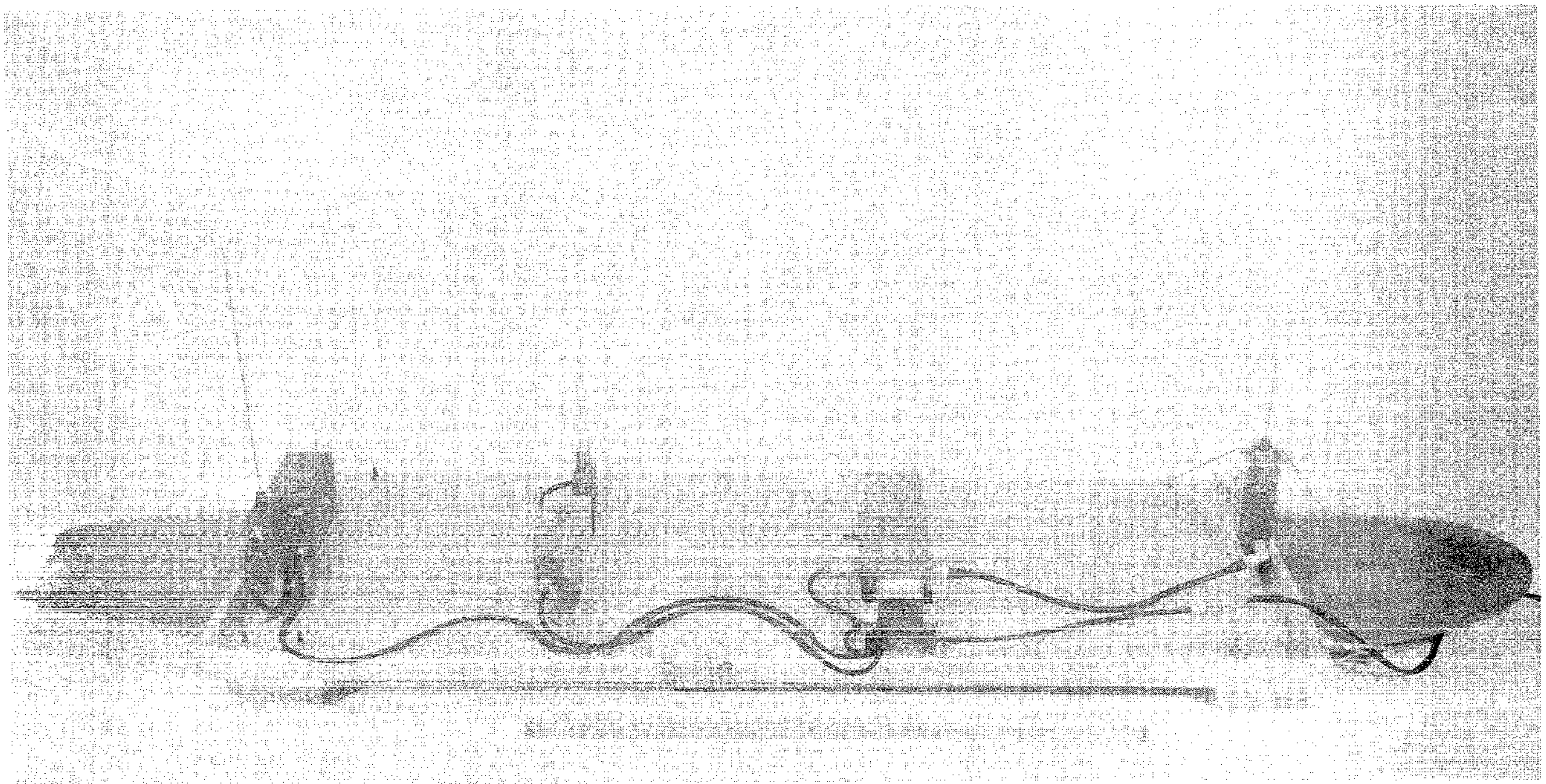

Figure 1. Transmitter float assembly.

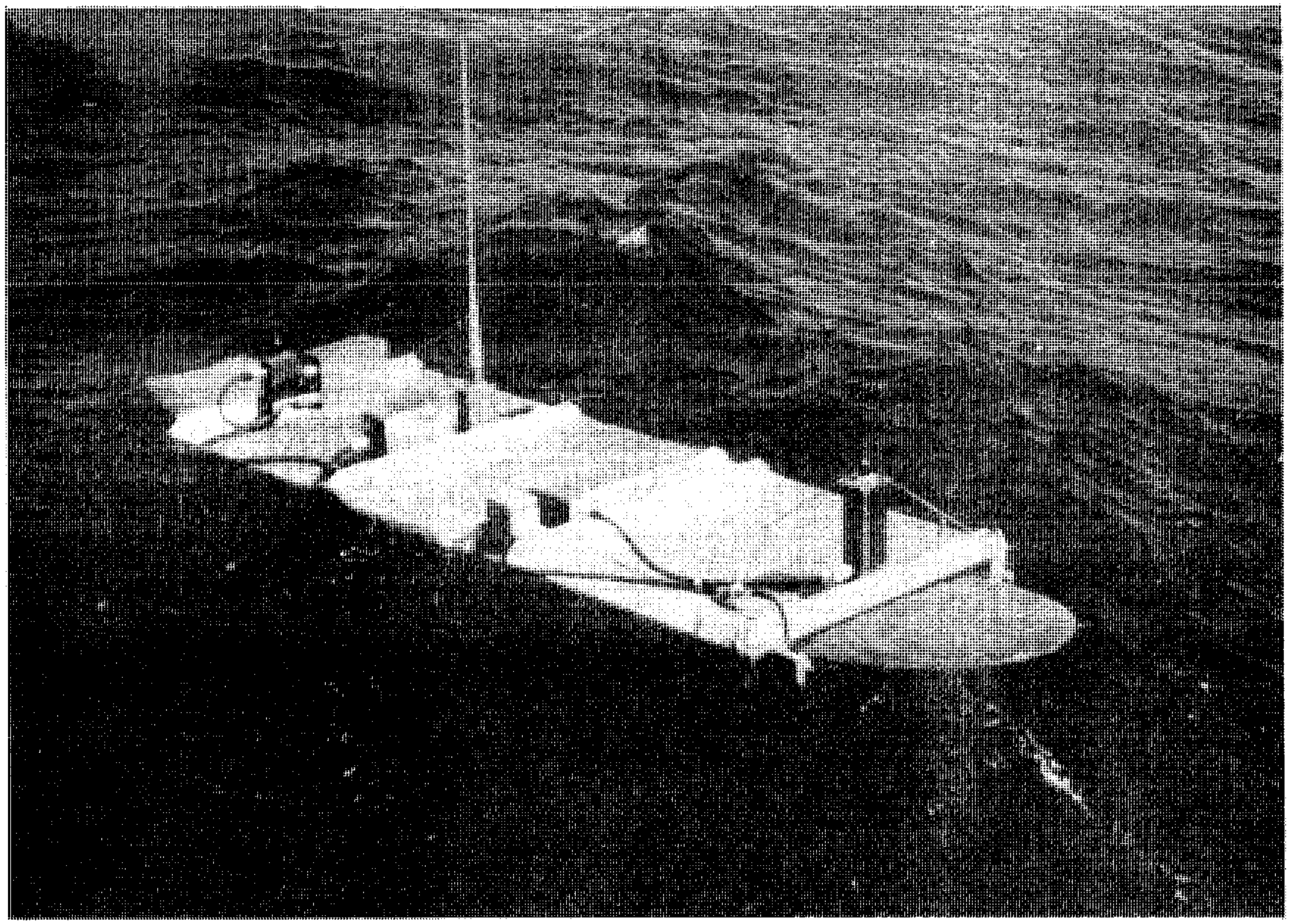

Figure 2. Transmitter float in use.

As indicated in figure 3, the battery supply included a low-differential regulator, overload protection, and a low-frequency keyer which served to identify the transmitted signals and provide a periodic zero-reference for the recorder. Although it was not usually needed, a duplicate power system was available as a backup.

The antennas were vertically-polarized stubs over a ground plane that floated barely above the water surface, and was sometimes under it. At the lowest frequency, 30 MHz, it was necessary to insure a more definite grounding to the sea water, as the metal plate was by itself too small to permit proper antenna loading after the battery bracket was removed. Changes in transmitter current were detected as waves washed over the platform, indicating a variable load. This was largely eliminated by galvanized mesh wrapped around the platform and under the surf board. The 30-MHz antenna was kept below 3-ft total height by the use of a tapered helical loading coil in its base. Although a good match could be obtained, this loading coil became quite warm after prolonged operation. Considering the area and temperature rise, it was estimated that about one-half the generated power was being lost as heat. The other antennas presented no problem, except that at 412-MHz elevated ground-plane radials were needed to prevent excitation of the coaxial feed, and thus provide a consistent match.

Sealing against sea water seepage was somewhat difficult. On "fixed" joints, Dow Corning 3145 RTV adhesive sealant was very satisfactory, if properly applied. "Removable" connectors for coaxial line and dc power were made successfully leakproof by being sprayed first with silicone compound in a volatile solvent, and then liberally "buttered" with Dow Corning type 103 silicone compound. One major problem occurred during the first day of testing at sea, when an unnoticed pin-hole leak in the 412-MHz transmitter caused that unit to be disabled. Corrosion was so great that complete rebuilding was necessary. Therefore, tests during the first two weeks used only the 30- and 140-MHz frequencies. A much slower leak, after about 3 weeks, caused erratic functioning of the 140-MHz transmitter. In this case, field repairs made it possible to complete the series of tests, but at an 8.2-dB reduction in rf power output.

Listed below are the rf power outputs actually obtained with the three transmitters:

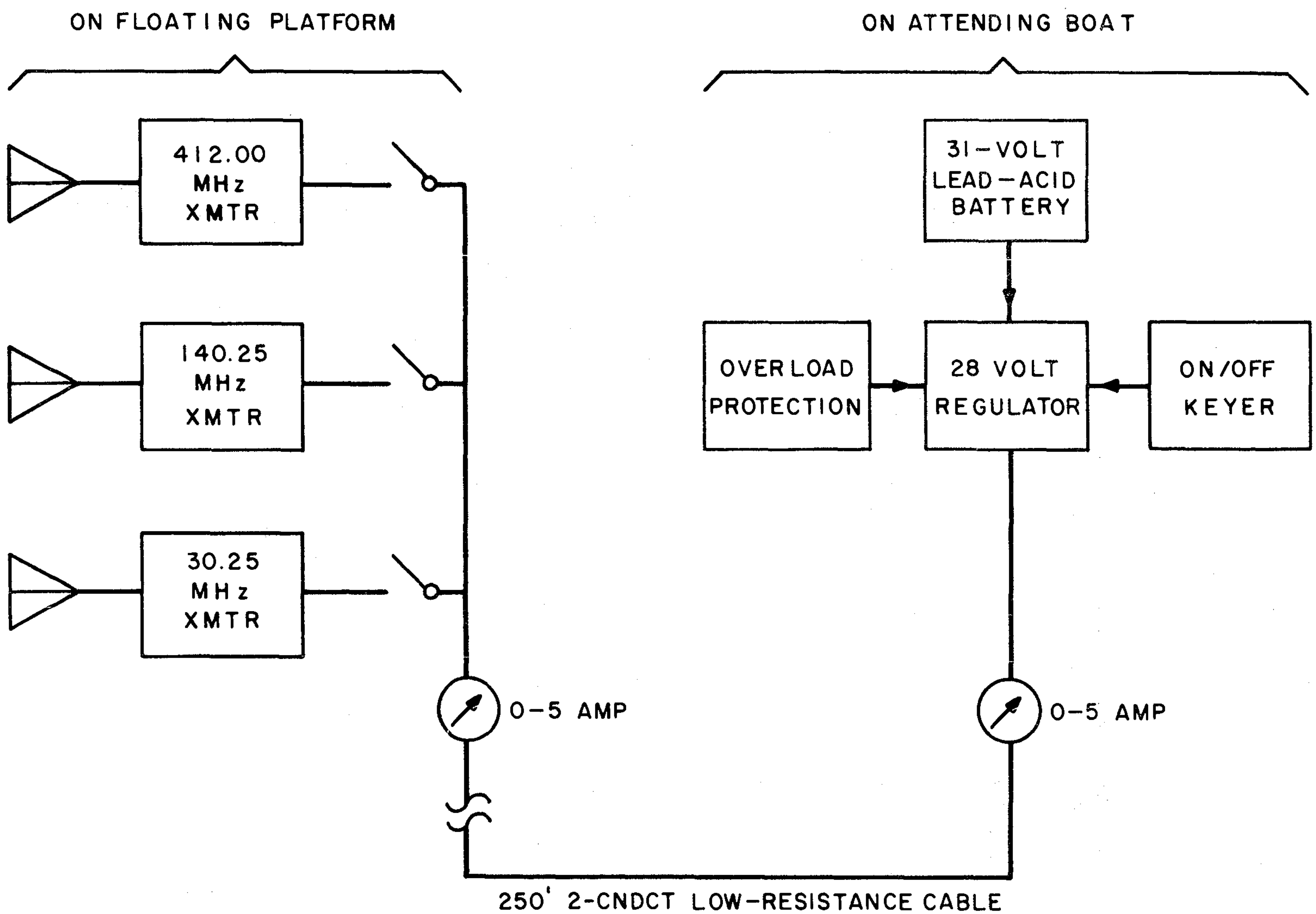

Figure 3. Transmitting system.

(MHz)	(W)
30.25	- 15 (≈8 W radiated)
140.25	- 15 (2.25 W after repairs)
412.00	- 6 (after rebuilding)

Schematics of the three units and of their power supply are included in appendix A.

5. RECEIVING SYSTEM

The receiving site (at Boca Raton, Florida) is shown in figure 4. The antennas on top of the tower are for S- and X-band radar systems with which range was measured. About half-way up the tower are the three antennas installed for the propagation experiment. Their mid-points are 54 ft above mean sea level. In the center of the tower is a 10-ft dish used for 412-MHz (and also intended for 1220 MHz), flanked by the 3-element 30-MHz beam and the 140-MHz log-periodic array. The three antennas were mounted on a common support which could be adjusted in azimuth approximately ± 30° by a remote control box in the instrumentation trailer. Without such adjustment, it would have been very difficult to maintain the transmitter float centered in the receiving beams, since the off-shore terminal was subject to Gulf Stream drift up to 3 or 4 knots. Figures 5 through 8 are additional views of the antenna systems. Listed below are the gains of the three antennas, in dB above isotropic, at each of the four originally assigned frequencies, as well as their effective cross sections in square meters.

Frequency (MHz)	Gain (dB)	Area (m^2)	Antenna Type
30.25	8.0	49.2	3-element Yagi
140.25	10.5	4.04	log-periodic[a]
412.00	19.0	3.37	single wide-band feed on 10 ft dish[b]
1220.00	30.0	4.81	

[a]Scientific-Atlanta Model 20-2 (120 to 150 MHz).

[b]Scientific-Atlanta Model 22-10 Reflector, with Model 27-0.4/10 Feed (0.4 to 1.7 MHz).

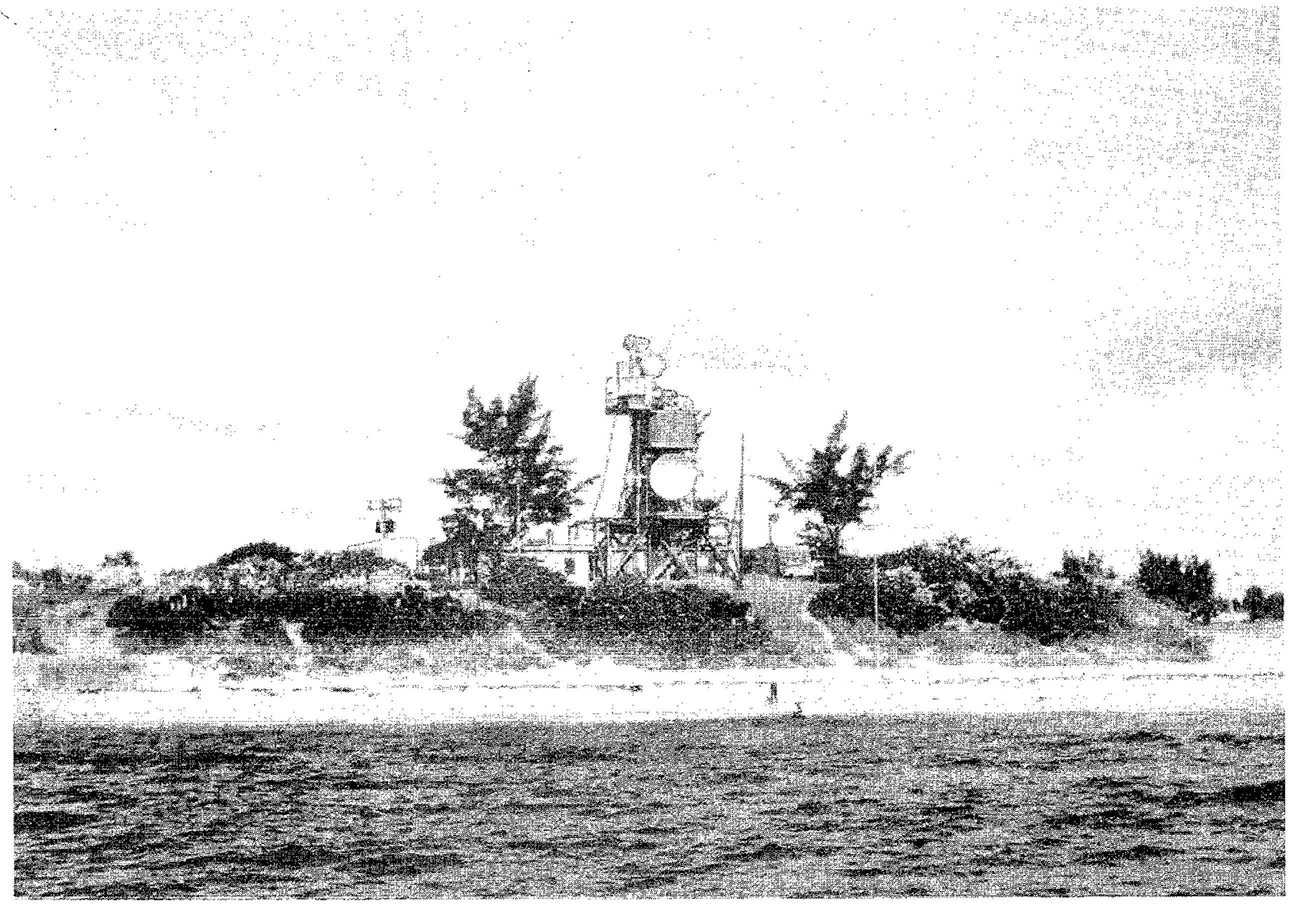

Figure 4. Receiving site, Boca Raton, Florida.

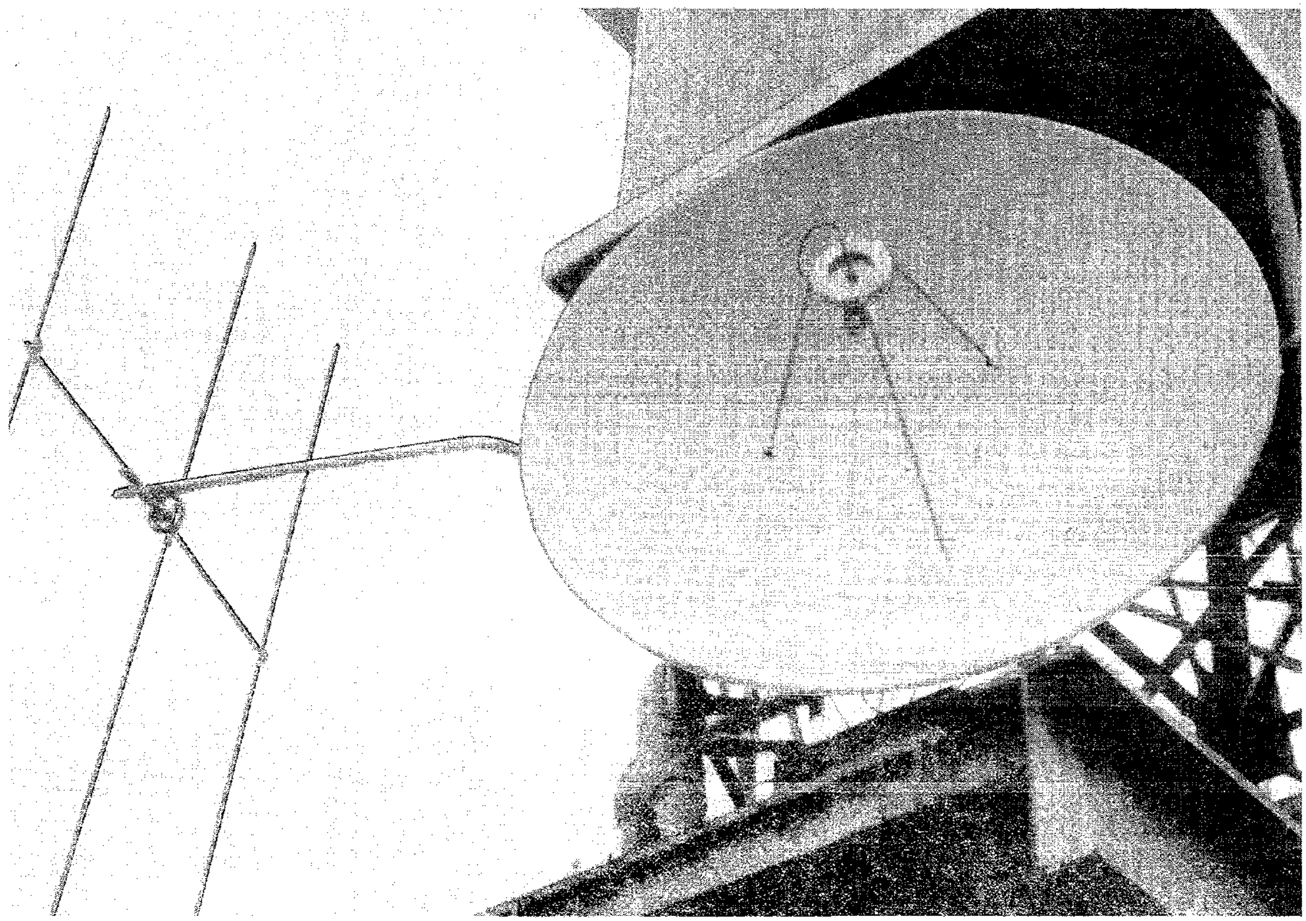

Figure 5. Antennas for 30 and 412 MHz.

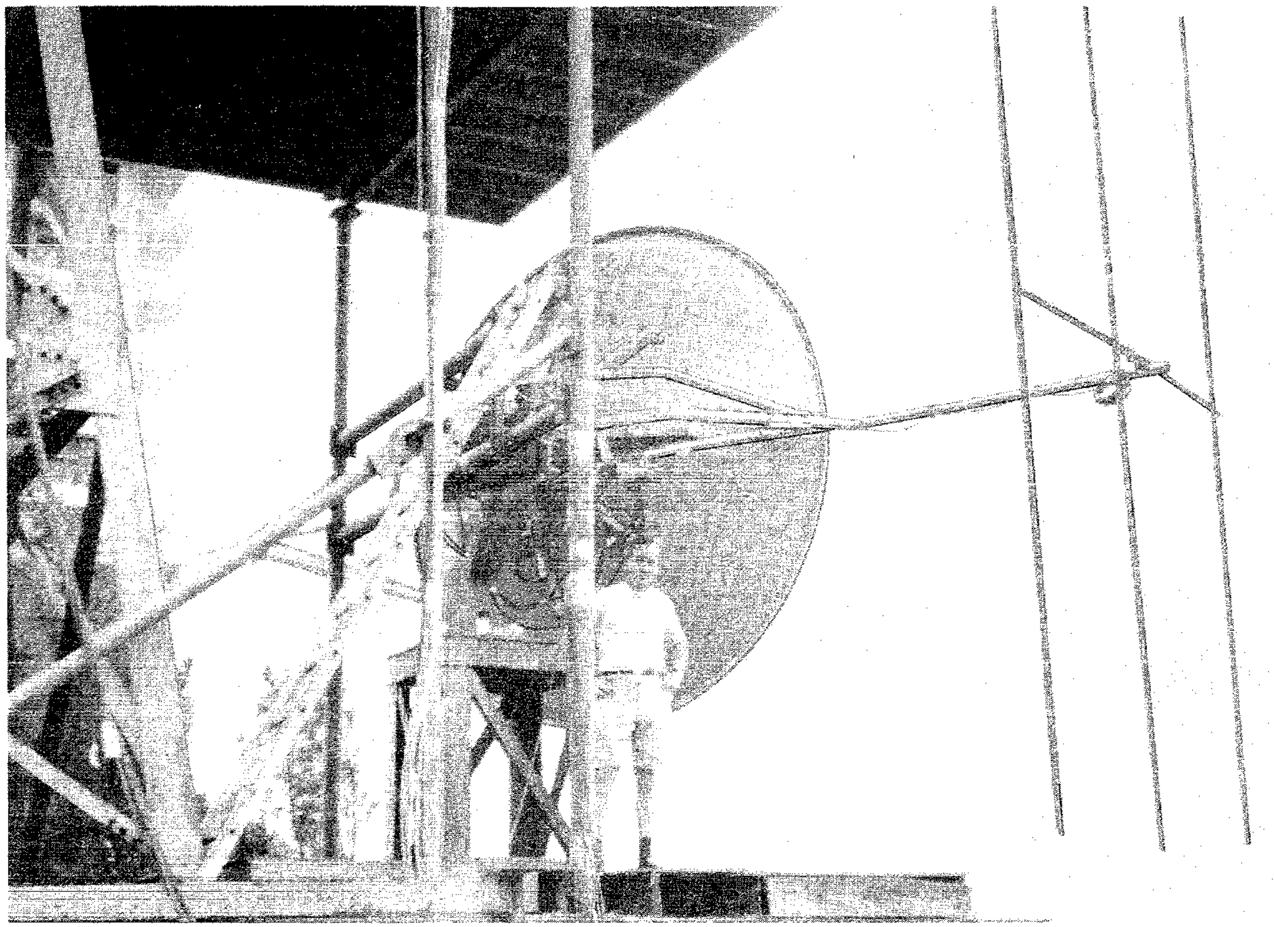

Figure 6. Antenna boom assembly.

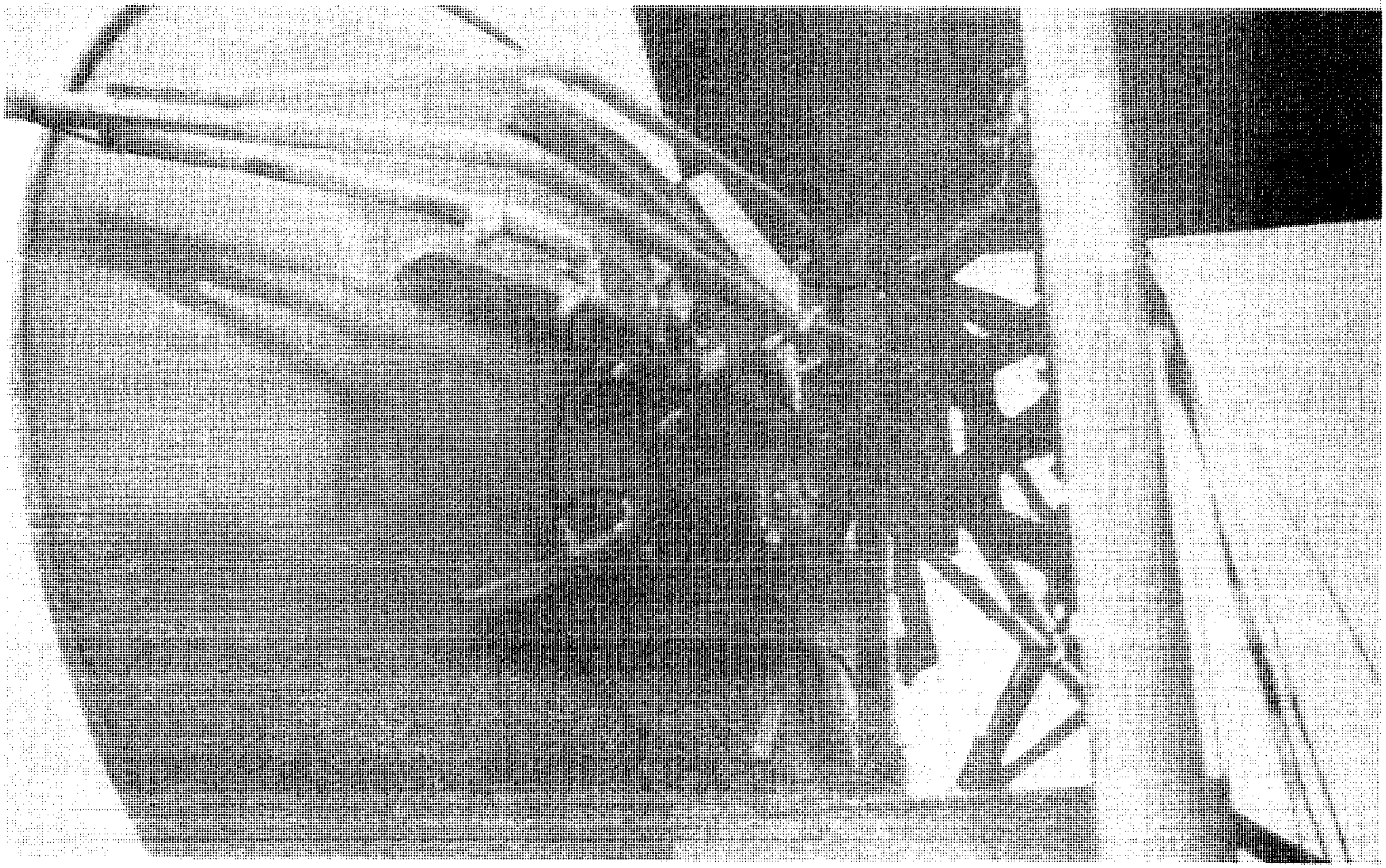

Figure 7. Mounting of down-converters and filters.

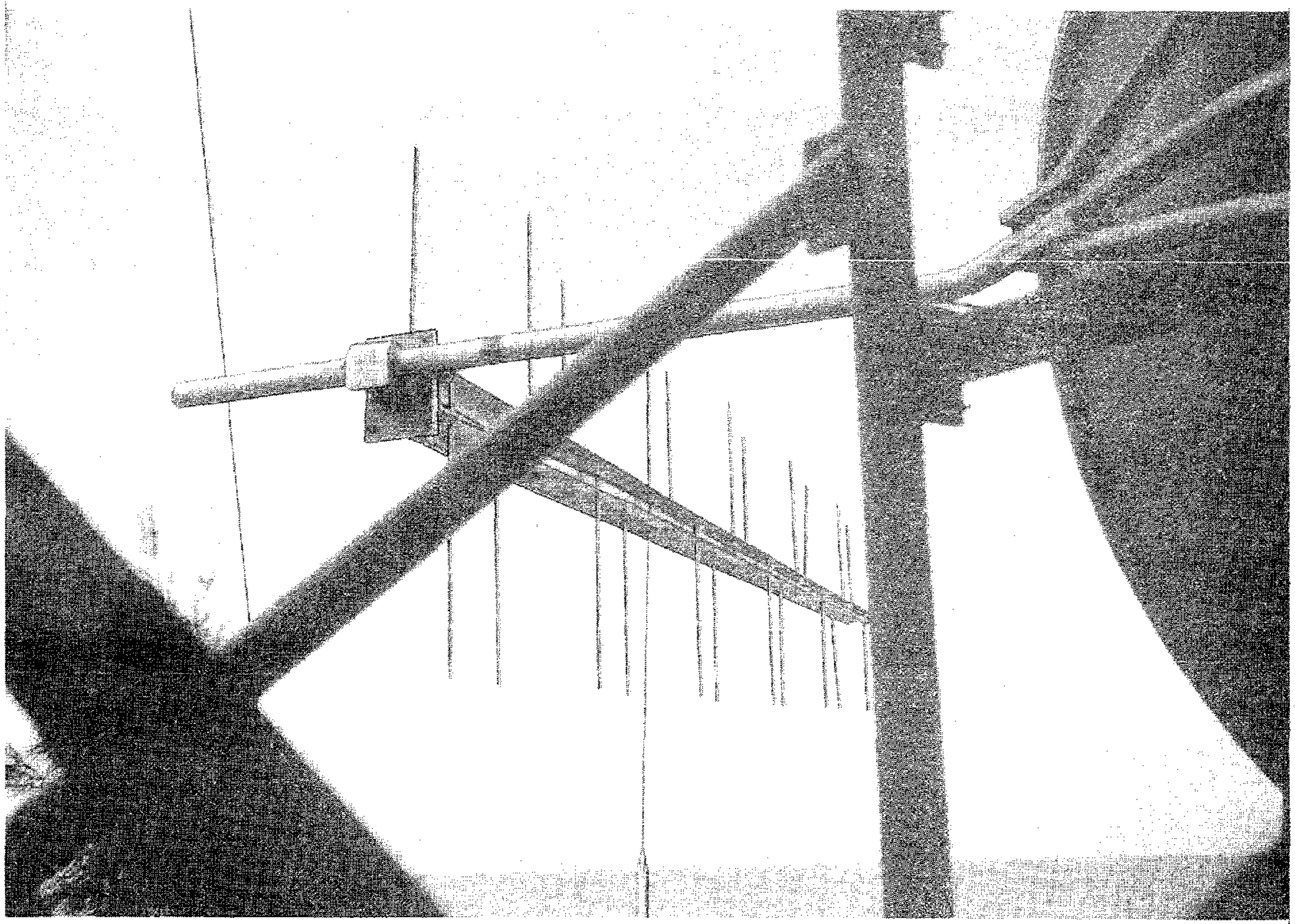

Figure 8. 140-MHz log-periodic antenna.

Low-noise, crystal-controlled down-converters for both 140 and 412 MHz were constructed in weather-tight boxes and mounted on the support beam for the antennas as shown in figure 7. By mounting them thus, high-frequency losses in the 100-ft cables to the instrument van were avoided, and overall noise figure improved. To minimize inadvertent mixing with rather high-level radar backscatter, coaxial low-pass filters were inserted at the input of each converter, together with directional couplers for calibration purposes. Schematic diagrams of the two converters are included in appendix A.

The receiving system block diagrams, divided by frequency for simplicity, are shown in figures 9, 10, and 11. Outputs from the two converters and the direct output of the 30-MHz antenna were connected by cables approximately 100 ft long to three separate Hammarlund SP-600 receivers. Various outputs from these receivers then went to a Brush Series 1707, Mark 200, 8-channel oscillograph. The only outputs useful for signal measurement purposes were those directly from the second detectors. Difficulties experienced in calibrating AGC curves, tracking one receiver with another, and observing small changes in signal strength, led to the use of the receivers as essentially constant-input detectors at such a low level that AGC was ineffective, so that operation was in a more-or-less linear mode. Auxiliary pre-detector outputs at 455kHz were useful in combination with the true-rms voltmeters in determining the level of received signal power to equal the equivalent input noise power - a fundamental measure of receiving sensitivity. Listed below is the approximate signal power to double the (455 kHz) output signal-plus-noise power for an estimated IF bandwidth of 3 kHz.

(MHz)	(dBm)
412	-126
140	-124
30	-100

The two higher frequencies were limited by converter input noise figure. At 30 MHz, on the other hand, sensitivity was limited by atmospheric noise and other interference. During test transmissions, signals were always well above these thresholds at any range used.

A stable signal generator and accurate frequency counter were used to spot exact frequencies for reception.

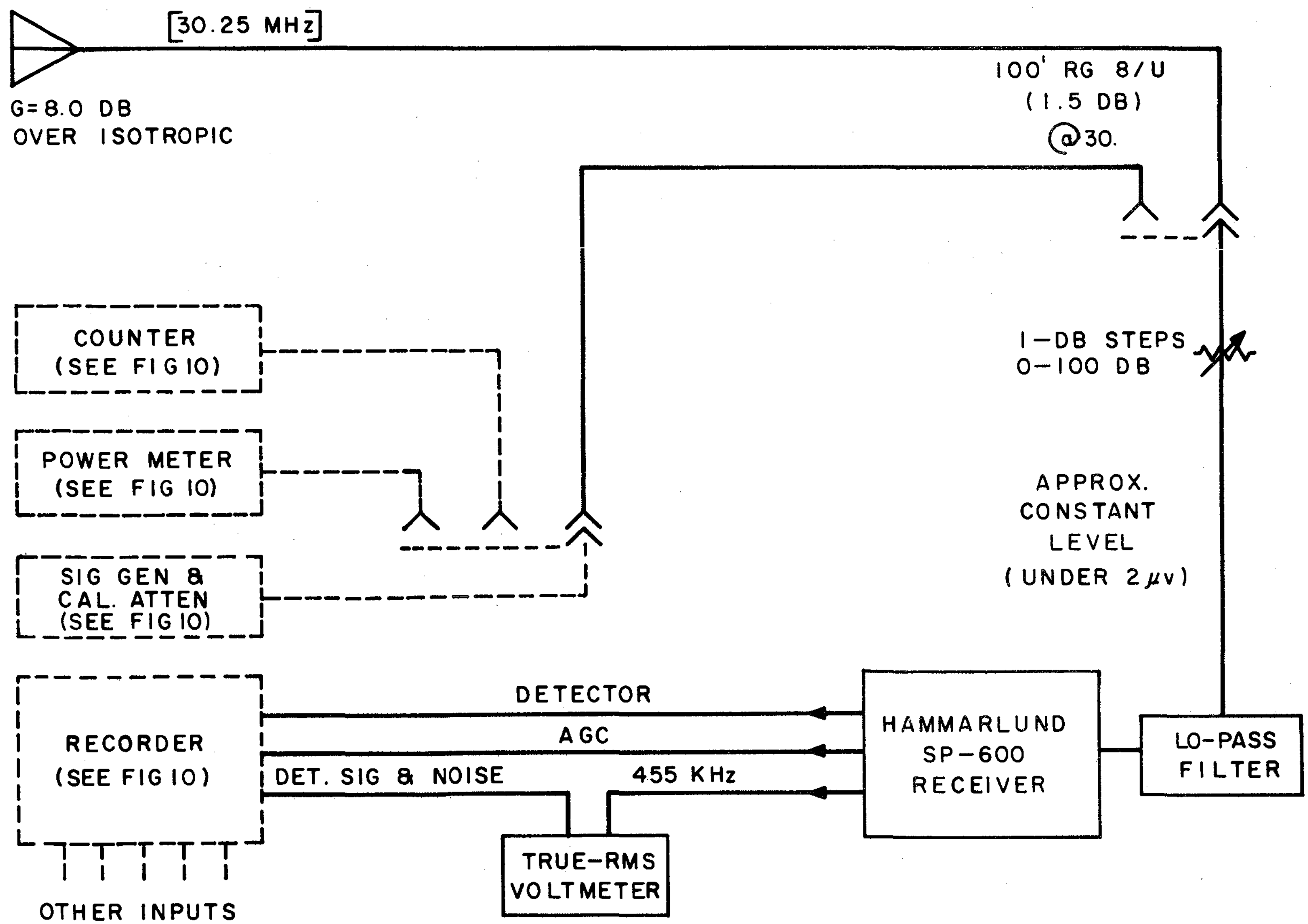

Figure 9. 30 MHz receiving system.

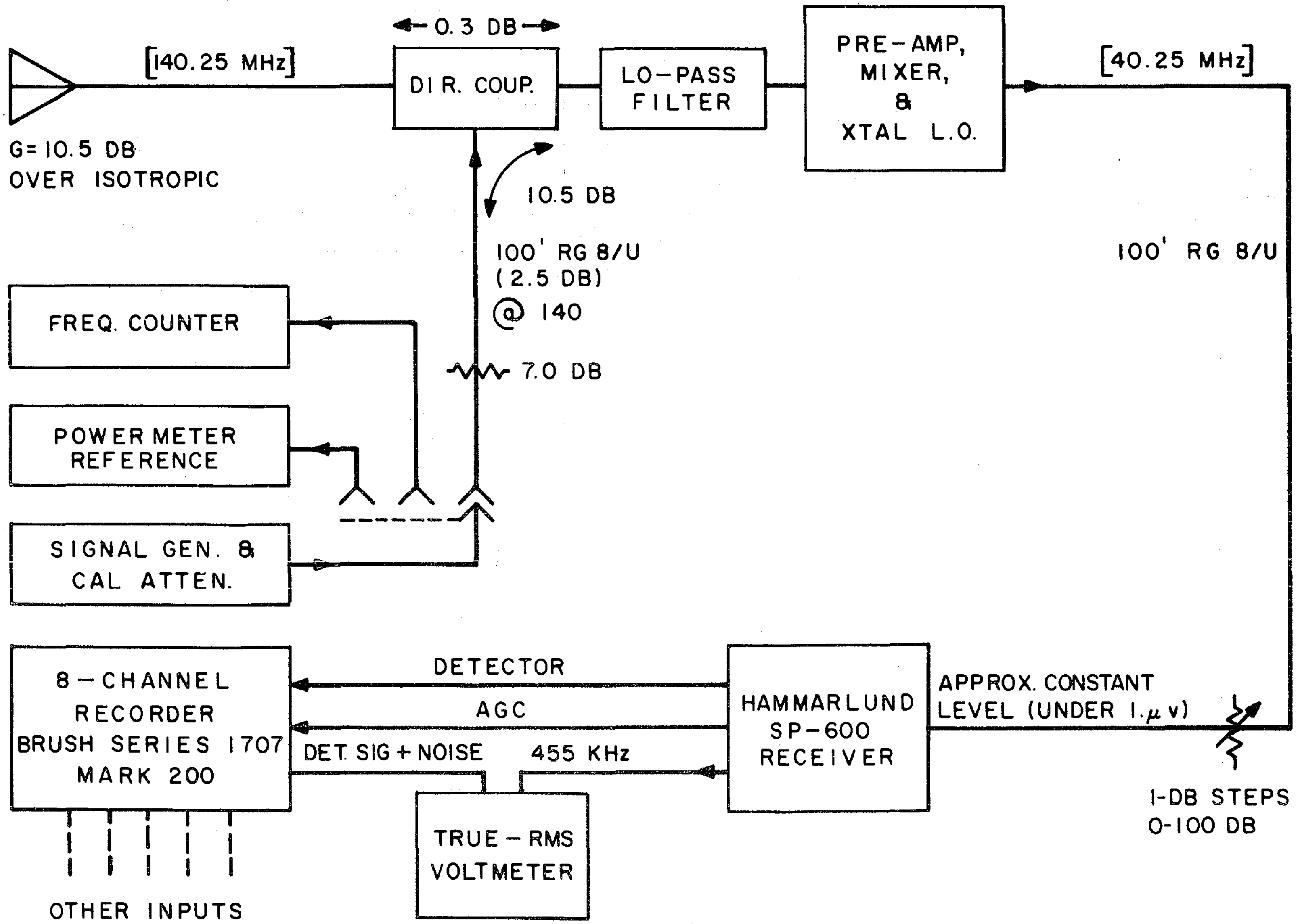

Figure 10. 140-MHz receiving system.

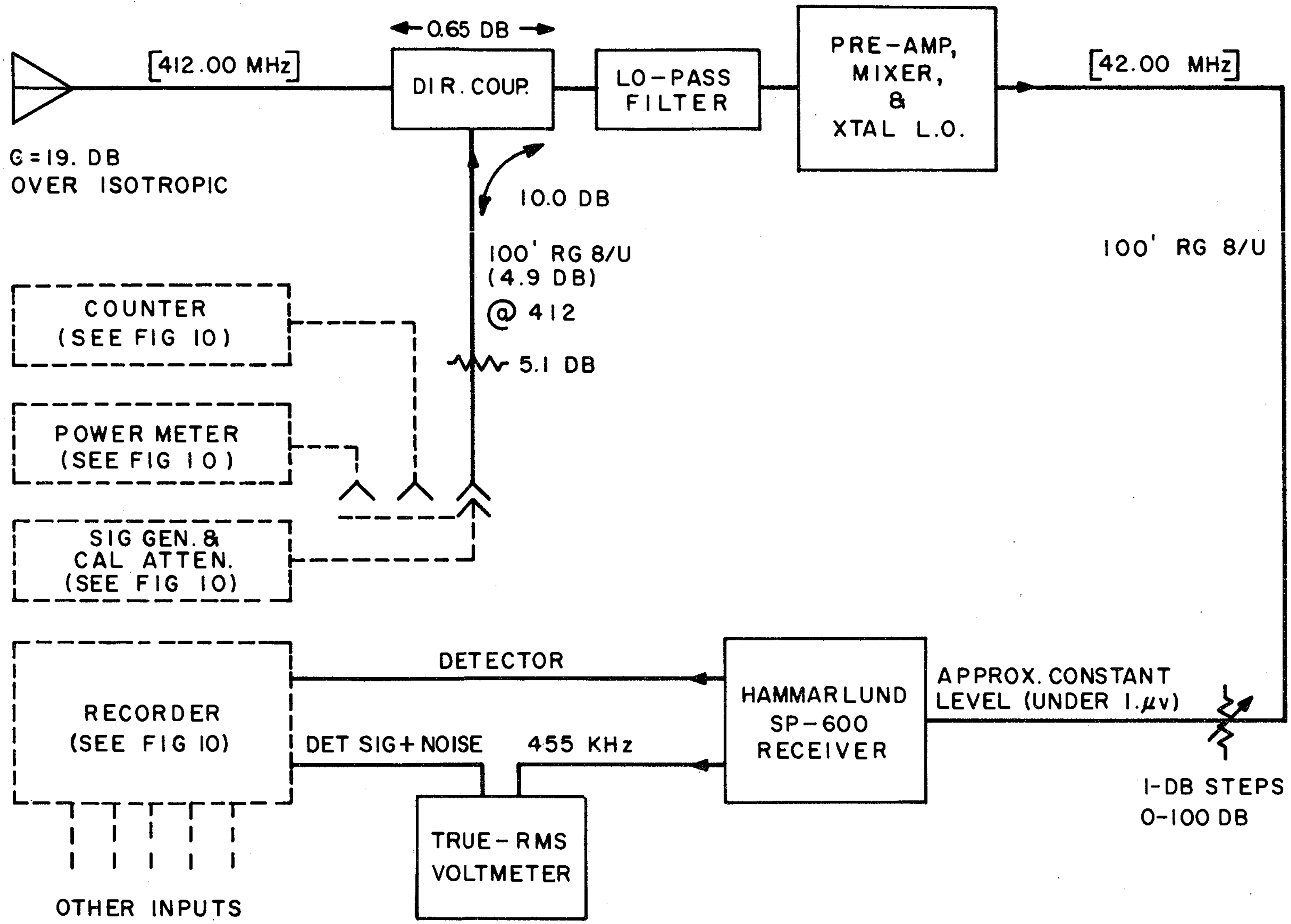

Figure 11. 412-MHz receiving system.

A reference power meter aided in setting levels for received signal strength calibration. Figures 10 and 11 show that a calibration cable was run up the tower for each converter. The total loss through it and the directional coupler to the converter input was adjusted to be exactly 20 dB, to facilitate determination of the injected signal from the setting of the generator in the trailer.

The trailer and interior instrumentation are shown in figures 12 through 15.

6. EXPERIMENT

Field operations extended over the period 28 August through 24 September 1970, with a subsequent week in October to dismantle and return the instrumentation van. Propagation data were taken on five occasions; but the first of these was deemed unreliable because of procedural difficulties in calibration. A sixth occasion was aborted before data could be obtained because of damage to the propellor of the support boat. The table below summarizes pertinent information on the respective occasions.

3 Sept - Range to 20 naut mi - data questionable - leak disabled 412-MHz transmitter - handling difficulty made evident need to redesign. - calm day.

8 Sept - Range to 30 naut mi - some data uncertain - calm day - waves: 1 to 2 ft swells - range limited by boat speed and navigation uncertainties.

10 Sept - Range to 40 naut mi - good data - calm day - range limited by boat speed and navigation uncertainties - waves: 1 to 2 ft swells on light chop.

16 Sept - Range to 10 naut mi - good data - seas 10 to 16 ft limited safe range - 412 MHz transmitter again in operation.

21 Sept - Aborted after 8 naut mi - no test - damaged propeller.

22 Sept - Range to 15 naut mi - good data - 140 MHz transmitter with reduced output power - operation in rain squall - range limited by weather, 8 to 10 ft seas and low boat speed. - many scattered thunder storms.

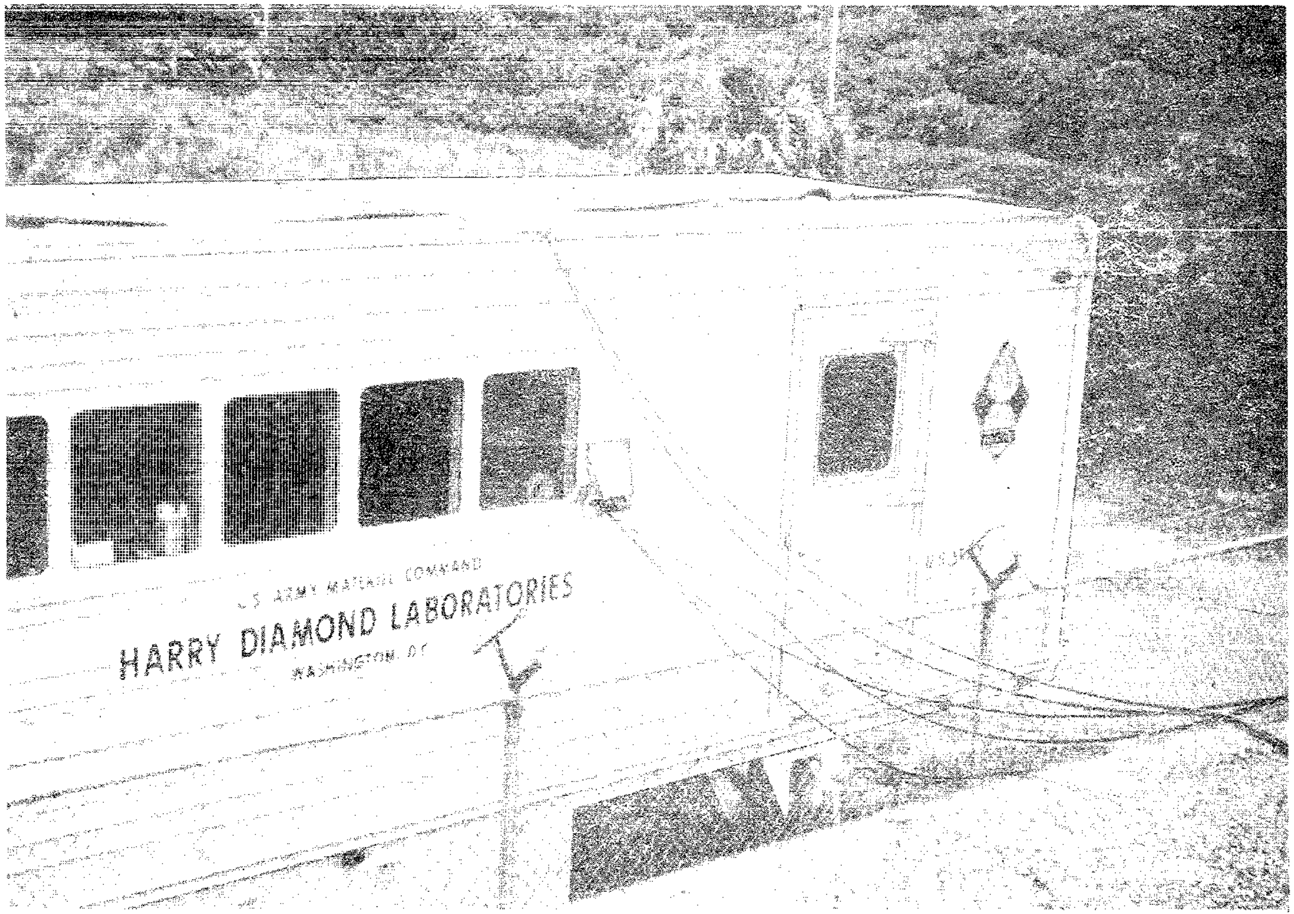

Figure 12. Instrumentation trailer.

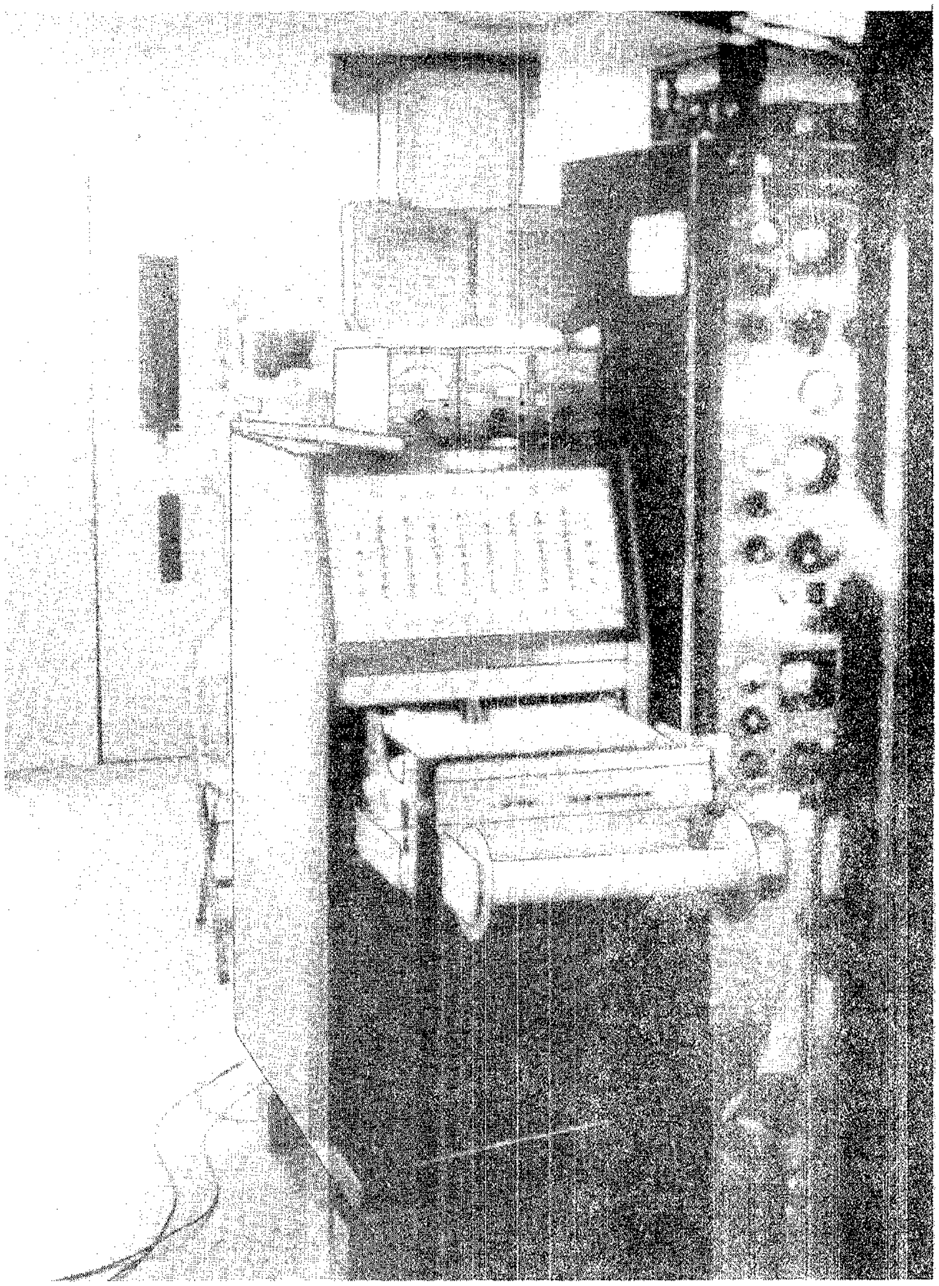

Figure 13. Receiver rack and 8-channel recorder.

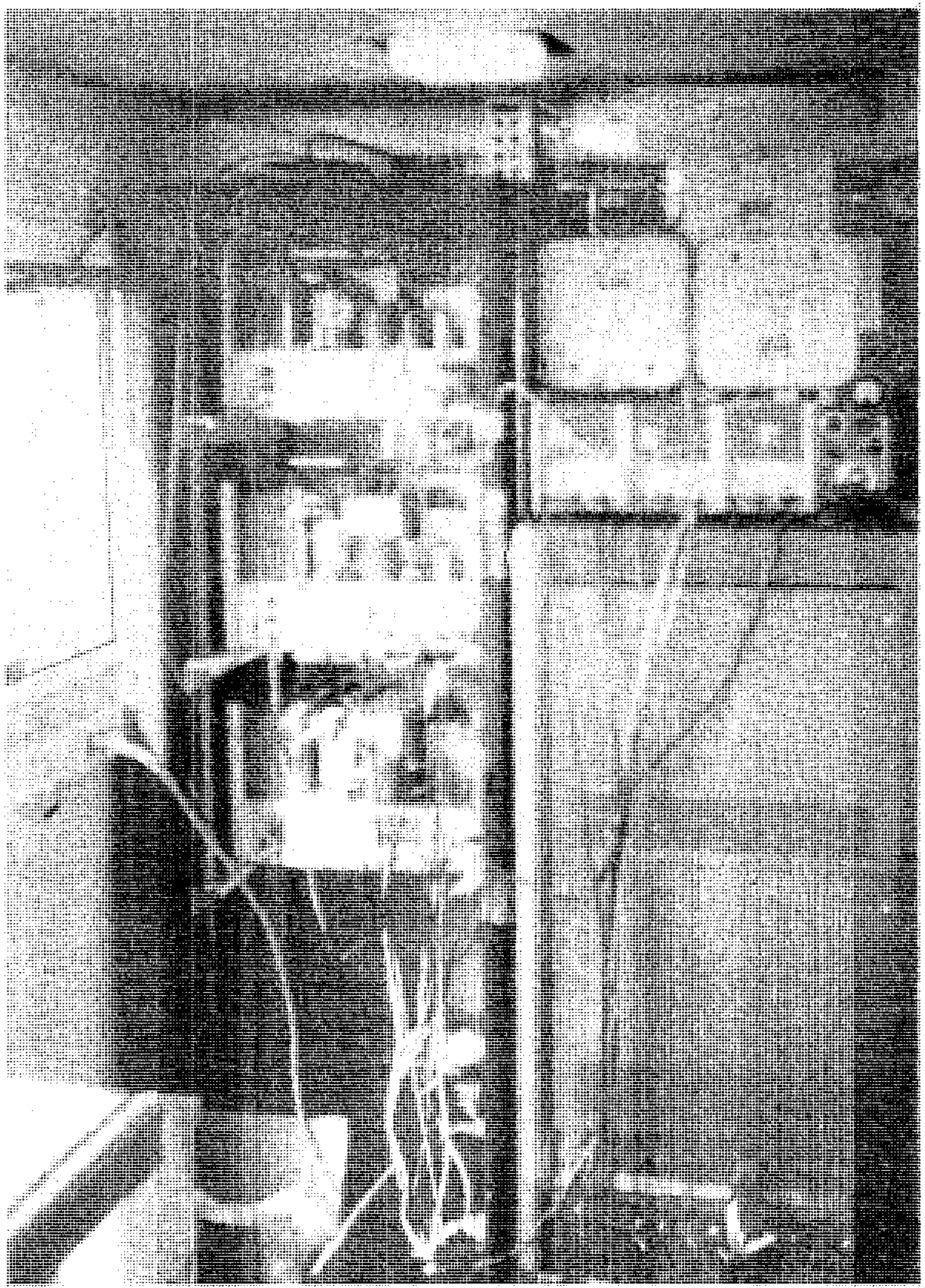

Figure 14. Rear of receiver and recorder racks.

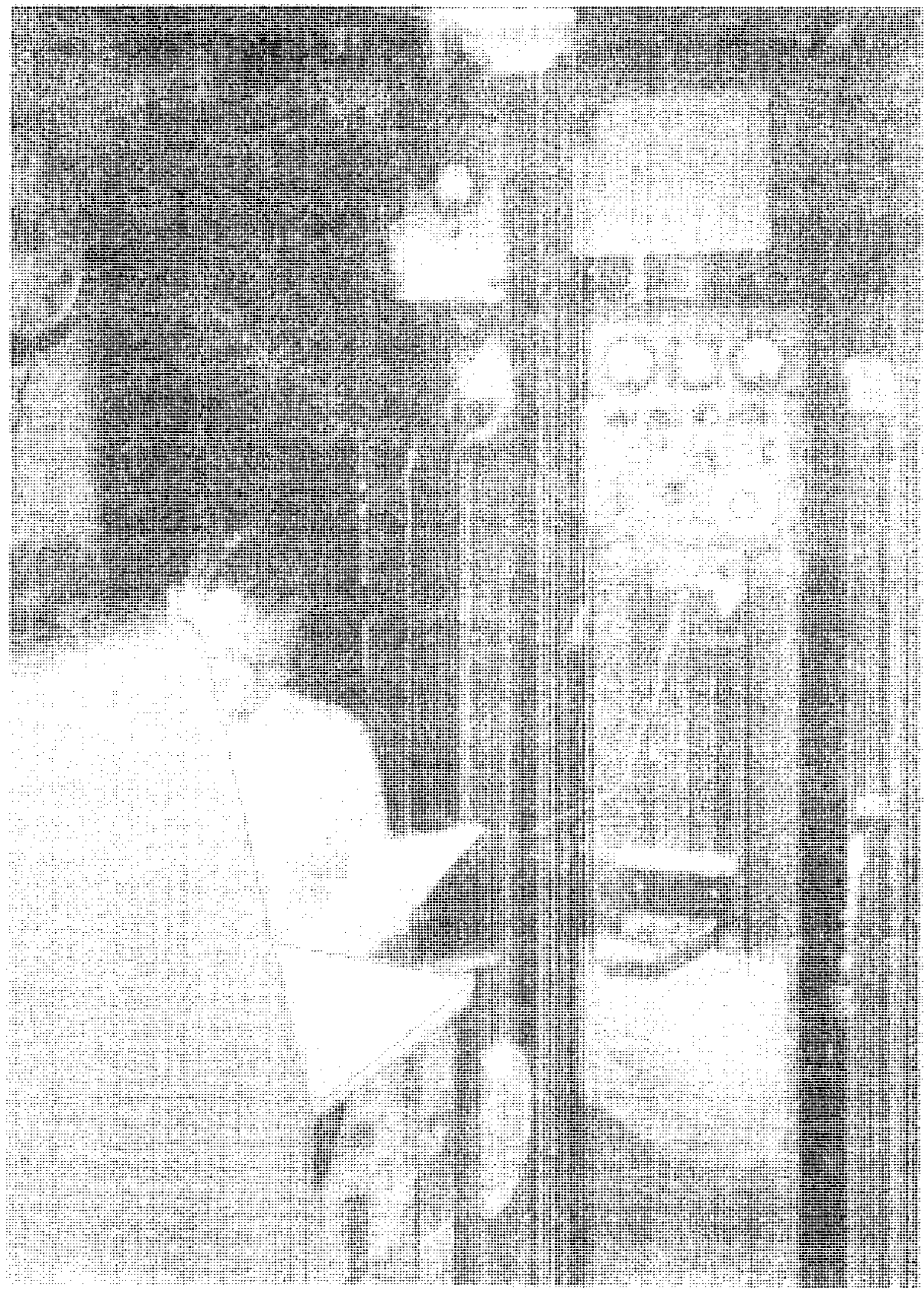

Figure 15. Calibration and communication equipment.

Between tests, much time was spent calibrating or modifying equipment and waiting for satisfactory weather.

Since the attending work boat was used for other charters and salvage operations when not actually needed by the experiment, all apparatus had to be installed and removed for each test occasion. This included the transmitter float assembly, battery supply and spare, cable reel, communications transceiver and antenna, radar corner reflector and mast, and tool chest. Although the boat was equipped with marine band and "citizens band" transceivers, the nature of the experiment made it desirable to utilize the specially assigned frequency of 36.20 MHz for communications regarding the test. Using this essentially clear channel and about a 10-watt output at each terminal, voice contact between the boat and the instrumentation trailer was of high quality out to the maximum range tried of 40 naut mi, even though only vertical whip antennas were used. Even the lower powered "citizen's band" equipment would have been adequate if other co-channel signals had been absent. These frequencies are close to the lowest one used in the test.

To enhance the radar return from the low and relatively small 45-ft work boat, a wire mesh corner reflector was installed on the highest mast (20 ft) which could be securely jury-rigged to the deck. Positive identification in case of multiple targets could be made by rotating the reflector to modulate the return distinctively. Even with enhancement, the maximum radar detection range was about 22 to 25 naut mi. Two methods were used to extend this. The first was the extrapolation of a plotted true course from previous radar data, on the basis of time at a measured ground speed and direction. This was considered useful for only moderate extensions of 5 to 10 miles because of variations possible in the Gulf Stream, which had varying velocities up to 3 or 4 knots and wandering direction. Intermediate stops for test purposes also caused errors because of continuing drift. A second method of obtaining check points extended positive range measurement beyond 30 miles. This was the use of large ocean-going freighters or high-flying aircraft as common objects identified both by radar and by visual sighting from the support boat. These fortuitous targets were radar-detectable at at least 30 naut mi ranges. If they also happened to be within 5 miles or so of the support boat, a shrewd guess of range and bearing was sufficient additional data. By these two means, distances out to 40 naut mi were obtained with reasonable accuracy. Another method was prepared, but not used, in which a kite was designed to lift a corner reflector to heights of several hundred feet for better radar visibility. Available time and the limited speed

of the support boat did not permit an attempt at greater ranges, however. Equipment for more conventional electronic position-finding was not available.

Certain limitations of the support vessel complicated the experiment. In calm water, approximately a 10-knot speed could be maintained. When heading into appreciable seas (the usual case with easterly winds), and correcting for Gulf Stream drift, the boat's speed was cut to about 2 to 4 knots ground speed; this is an impractical speed for covering much distance in interesting weather. In calm weather, the trip out to a 40-naut-mi range and return took 16 hr. On another day with swells between 8 and 16 ft, it required 11 hours to attain 10 naut mi and return. Although the lightened transmitter float (battery removed) could be lifted manually over the boat's side at each test distance, the process was awkward and time consuming. The float could not be towed. A faster boat of different design would have been preferable, towing a stabilized streamlined test platform which would not have to be taken aboard. Even better would have been the use of a helicopter, which could lower the test platform at selected ranges. Although this would be more expensive per hour to operate, more data could be obtained over far greater ranges at a total cost saving. A boat would still be operational under more severe weather conditions, however.

At each range, during a test series, the transmitter float was drifted out beyond the immediate vicinity of the boat to the limit of its power cable (250 ft), with the boat maintaining just sufficient headway to keep it from being in line with the transmission path. Thus oriented, no effect of the boat's presence could be observed. As previously noted, only two transmitters were operated at a time to minimize voltage drop; however the common unit provided continuity for comparing the other two. Early tests were made with continuous recording periods of 10 to 15 minutes, but this was later reduced to one to three minutes (assuming no unusual effects), as the increased time gave no further information and it was desired to conserve both time and battery charge.

At the end of each recording period, an immediate measurement was made of the value and range of signal strength actually received at each frequency. To do this, a known level from the local signal generator was substituted for the signal at each receiver (fig. 9 to 11) to provide approximately the same average recording amplitude. The attenuator at the receiver's input was changed both plus and minus several one-dB steps to provide the detail needed to interpolate variations in the propagated signal. Done in

this way, the receiver's characteristics did not affect the measurements.

It is of interest to note that the light-weight float rode large swells and shorter chop with a minimum of wash-over, when floating without any headway or tension on the tether rope. The effect of water washing over the ground plane and around the bases of the antennas could not be noticed in the received record compared with fluctuations believed caused by gross wave motion. Of course, occasional breaking chop and larger wind-blown water masses caused brief signal dropout by completely inundating the antenna support insulators (transmitters were protected from load shorts), but moisture remaining on the silicone-treated surfaces was not a problem. In fact, one period of successful operation was during a very heavy rain squall, in which severe drenching and splashing were present. The use of short antennas mounted only a few inches above the water surface is therefore not expected to be a great system problem, from this standpoint. The physical motions of the transmitter float and of wave conditions during a number of significant test periods were recorded on 16-mm motion picture film for later study. Although such data cannot be included with this report, it was of value in suggesting causes for certain propagation fluctuations, and in forming qualitative opinions regarding possible future test-float designs.

In the planning stage of the experiment, it was hoped that detailed meteorological data could be measured locally at each terminal of the transmission path for each test. This later proved to be too monumental an undertaking, complicated by the failure of certain sensors to perform as expected. It was necessary, therefore, to rely on other publically available regional weather data compiled by Georgia Tech as part of their supporting services contract with HDL (DAAG39-70-0053). This is discussed in section 7. Qualitative weather conditions were also recorded by still camera at the off-shore terminal. Three examples illustrate the range of conditions encountered (except for wind velocities and wave heights). The condition shown in figure 16 was most usually encountered, with sky mostly clear overhead and clouds over land surfaces and near the horizon. Figure 17 shows a typical overcast when general shower activity was forecast. A localized, very intense rain squall is shown in figure 18. Such squalls usually showed electrical activity which slightly affected the background noise in the lowest frequency receiver.

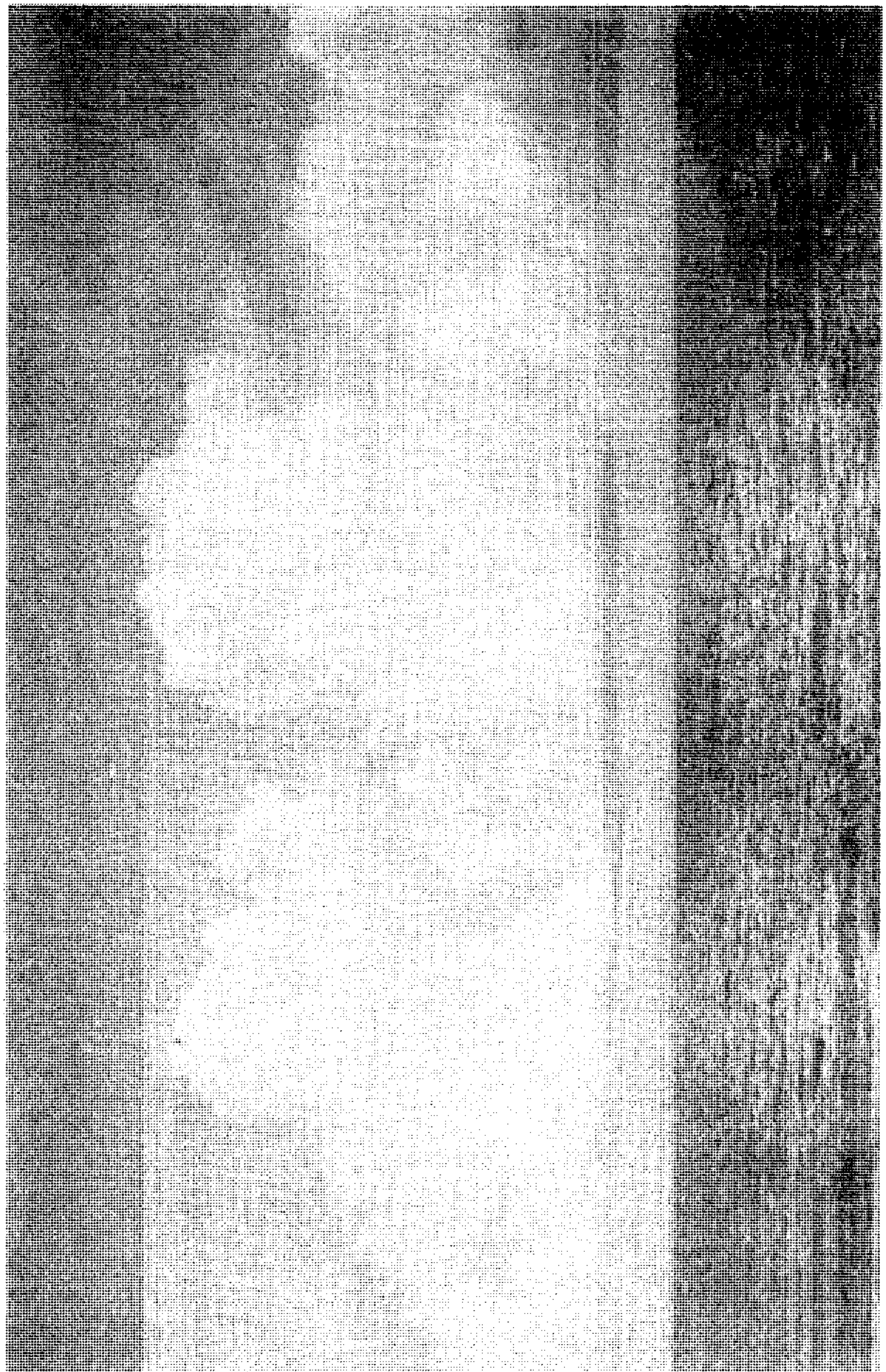

Figure 16. Typical good-weather conditions.

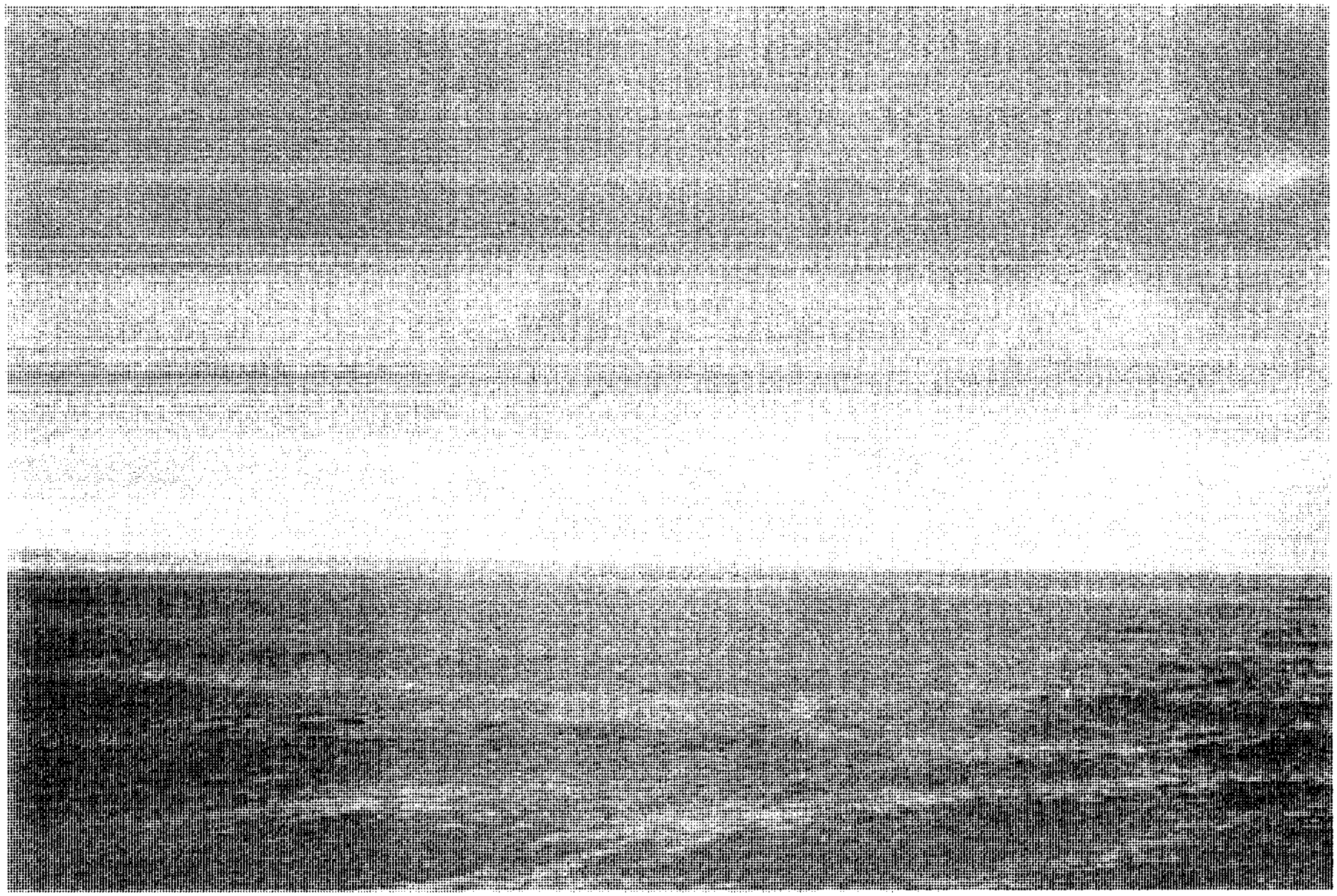

Figure 17. Overcast, predicted shower activity.

Figure 18. Typical local intense rain squall.

7. RESULTS AND DISCUSSION

All three frequencies could be used for communications reliably to 20 nautical miles or more with low transmitter power. It is evident from the following data, however, that several penalties are incurred by the use of frequencies above 140 MHz. For quite different reasons, operation at 30 MHz and below is also not desirable. Considering all factors, a broad recommendation is made to use frequencies between 50 and 100 MHz, and preferably about 75 MHz. Other particulars will be presented.

Figures 19, 20, and 21 show for 30, 140, and 412 MHz, respectively, the received signal strengths at the antenna terminals in dB relative to one milliwatt (dBm), as a function of range in nautical miles to the transmitter platform. The solid curves are calculated values in accordance with Norton[1] on the basis of the real receiving antenna conditions, a "standard" atmospheric gradient (no inversion), and 10 watts radiated power over a smooth sea. The vertical lines represent the spread of observed signal strengths as a composite of all valid data for the range in question. Since the transmitter outputs differed somewhat from the value used in the calculations, the observed data has been normalized for 10 watts radiated power in each case. Also shown are the equivalent input noise levels of the receiving systems (as discussed in section 5) and the theoretical propagation for plane earth.

A better appreciation of the penalty of going to higher frequencies can be had by considering figure 22. The theoretical curves of the previous three figures are again used, but those for 140 and 412 MHz are further normalized for the same receiving aperture (49.2 square meters) as the 30 MHz receiving antenna. This means that the 140 MHz antenna should have 10.9 dB more gain, and the 412 antenna 11.75 dB more gain, than those actually used, in order to extract the same power as the 30 MHz antenna from a given field strength. The differences shown on figure 22, therefore, represent only the effects of propagation at the three frequencies. Although normalization could be made for any frequency and gain, the separation between curves would be unaffected. The theoretical curves shown were calculated for vertical $\lambda/4$ transmitting antennas at zero elevation. If one applies, instead, the restraint given in section 3,

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[1]Norton, K. A., Dec. 1941, The calculation of ground wave field intensity over a finitely conducting spherical earth, Proc. I.R.E., pp 623-639.

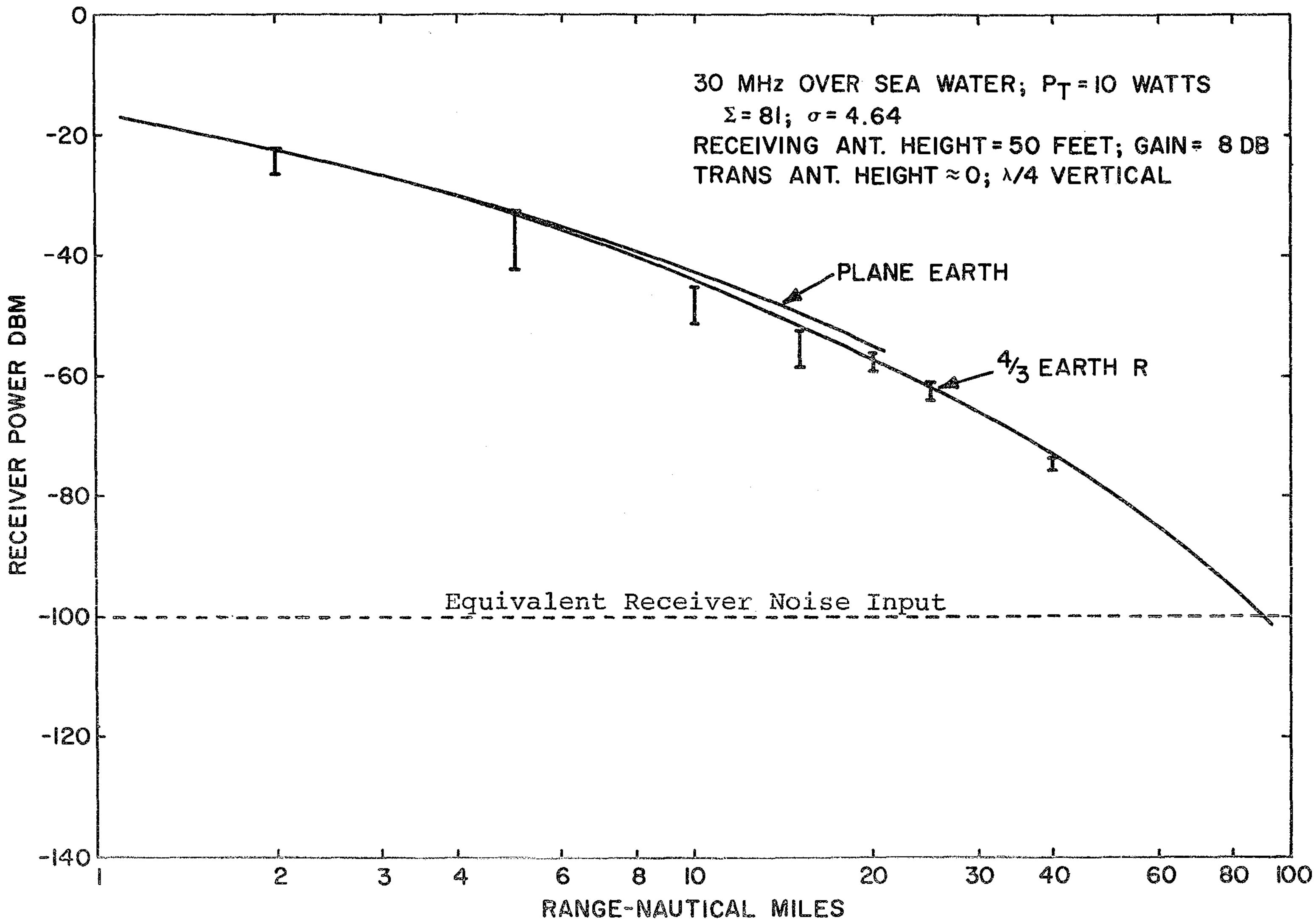

Figure 19. 30-MHz propagation.

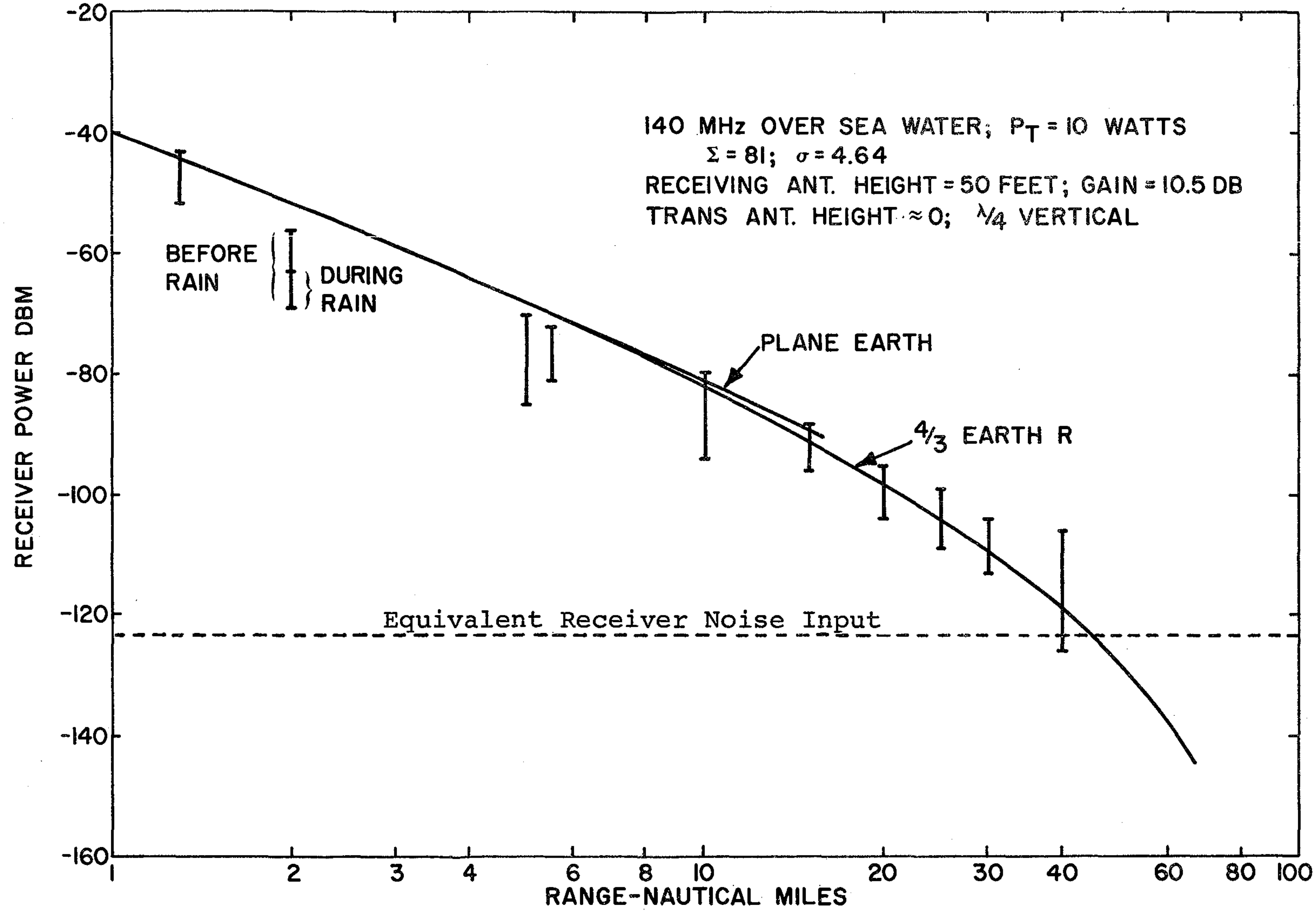

Figure 20. 140-MHz propagation.

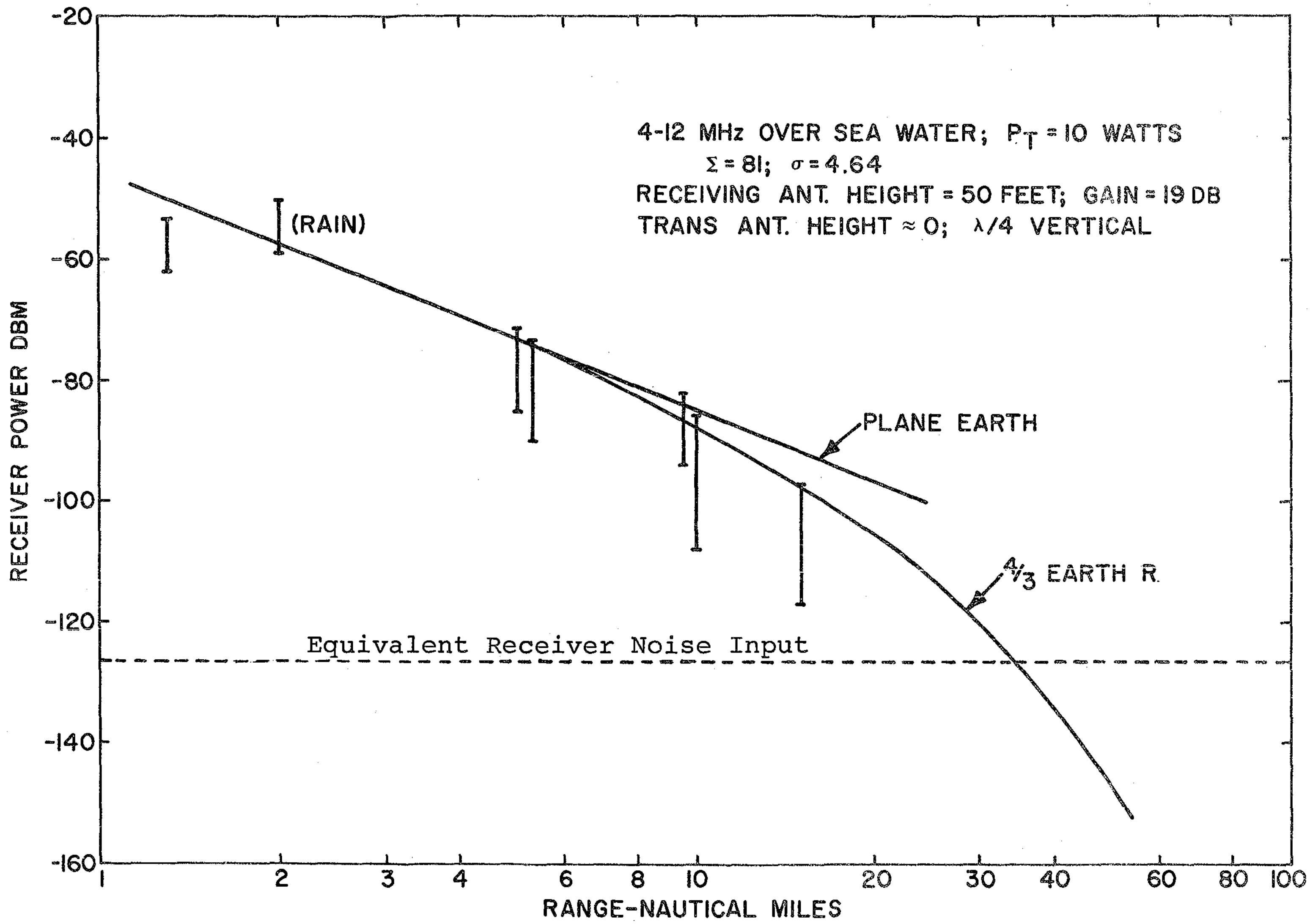

Figure 21. 412-MHz propagation.

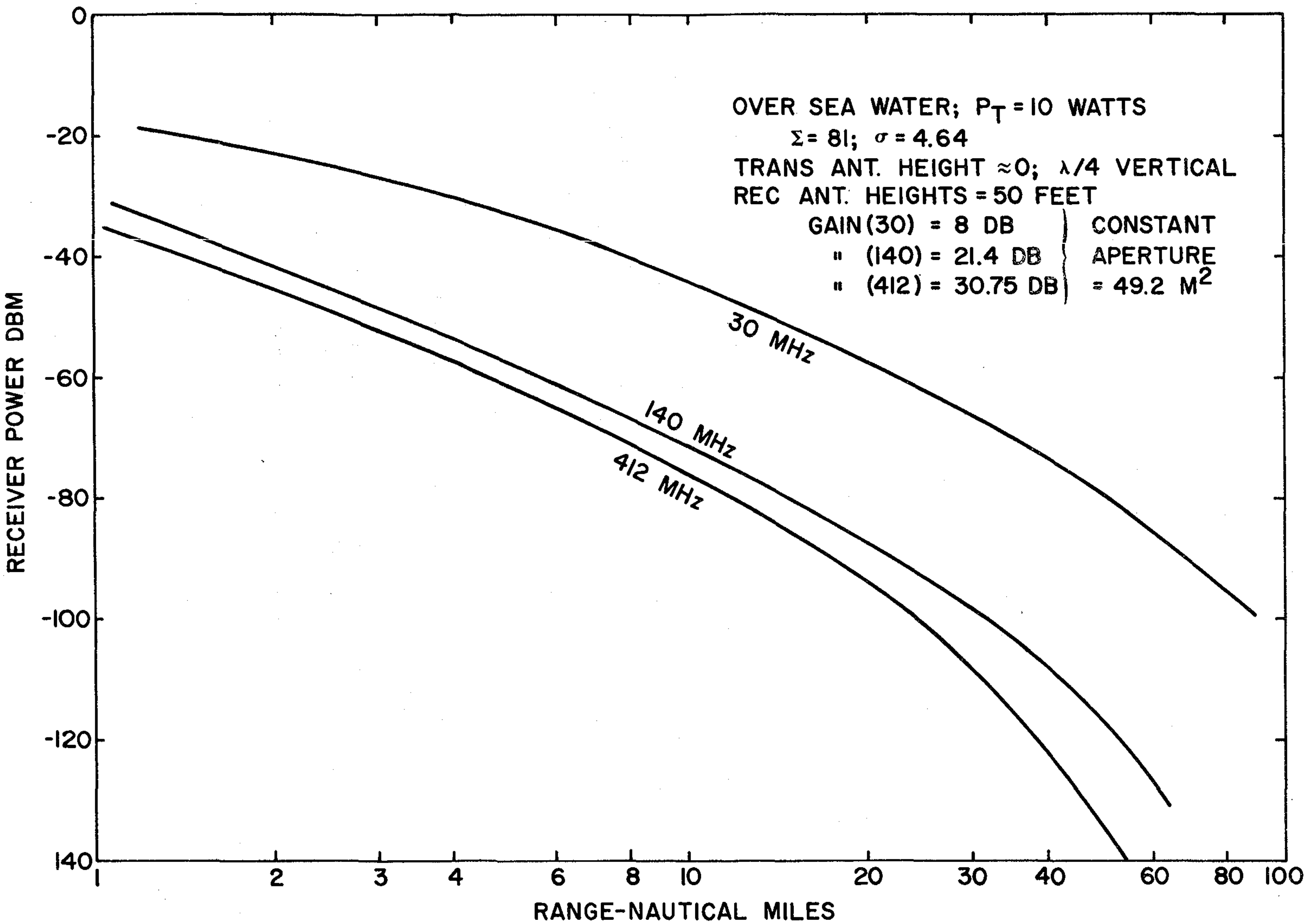

Figure 22. Propagation normalized for 30, 140, and 412 MHz.

namely, a 3- to 4-ft maximum antenna height, it is evident that certain improvements may be made in propagation at the higher frequencies. For example, a simple co-linear array can increase horizontal gain predictably, or a single radiating element can be elevated to the desired maximum height with resulting height-gain advantage, especially at the highest frequency. It is not certain, without further testing, that these theoretical advantages will all remain in the immediate presence of various surface wave conditions. In any case, the optimum frequency recommendation is unaffected.

Calculations[1] also showed some interesting facts regarding the height-gain properties of the receiving site, as tabulated below for a 50-ft elevation:

30 MHz	-1.2 dB
140 MHz	+2.8 dB
412 MHz	+18.5 dB

The height-gain advantage is range-dependent, but these figures apply for the longer ranges. At 30 MHz, a greater signal would have been received with the antenna at sea level. On the other hand, if the 412 MHz dish had been at about sea level, reception during actual test conditions would have been marginal beyond 10 naut mi. Presumably, at some frequency about median to 30 and 140 MHz, the effect of antenna height is inconsequential up to 50 ft or so.

Signal fading characteristics are an important subject for comment. Although it is a temptation to draw conclusions which cannot be strictly justified from the recorded data, the following general tendencies seem to exist:

(1) Higher frequencies have a greater fading range and a faster fluctuation in level.

(2) Fading range is not demonstrably a function of distance.

(3) Fading range may be somewhat greater with increased sea and wind states.

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[1] Norton, K. A., Dec. 1941, The calculation of ground wave field intensity over a finitely conducting spherical earth, Proc. I.R.E., pp 623-639.

(4) Fading at one frequency is essentially uncorrelated with fading at other frequencies, with certain uncommon exceptions.

(5) Fading may be separated into a slow component and a much faster component, more properly called "flutter." The two may have different causes.

(6) At 30 MHz, flutter may be correlated with the passage of long period (approximately 2 to 4 seconds) coherent wave fronts, or "swells." Although not determinable from present data, flutter at the higher frequencies may be the result of similar scatter from appropriately shorter period waves ("chop") local to the transmitter, thus explaining in part the observation of item 2 that such variations are not distance-dependent.

Other than the above, efforts to correlate propagation with varying meteorological conditions have not been possible. In general, atmospheric conditions during the entire series of tests were remarkably constant. Figures 19 through 21 show no significant behavior different from that of a standard atmosphere model; no evidence of ducting was observed at the frequencies and ranges employed. The meteorological data compiled by the Georgia Institute of Technology for this time period is given in appendix B, which is Attachment II of their final contract report. Some ducting tendencies may be seen in the plotted radiosonde data (fig. II-1 through II-3, and table II-1 of appendix B), but it is not evident for the days and times of valid data. Of possible interest is figure II-4 of appendix B, which relates required ducting conditions for various frequencies. Also included in appendix B are records of air and water temperatures, general weather log, and national weather maps for the test period.

An inspection of the spread of data points plotted in figures 19, 20, and 21 shows that signal level varies more at higher frequencies, but that for a given frequency, the variation is not obviously a function of distance. The nature of the flutter, and the manner in which it changes with frequency, can be observed in figures 23 and 24. The data were taken at 10 naut mi under conditions of 10 to 16-ft seas and mixed chop. Figure 24 shows four instances, rarely observed, of signal drop-out due to waves washing over the 412 MHz antenna. The 30 MHz signal shows cyclic variations which strongly suggest dependence on the larger wave components in period, as observed in the motion-picture record of that test. Dependence of flutter at higher frequencies on wave action is less obvious, perhaps because of

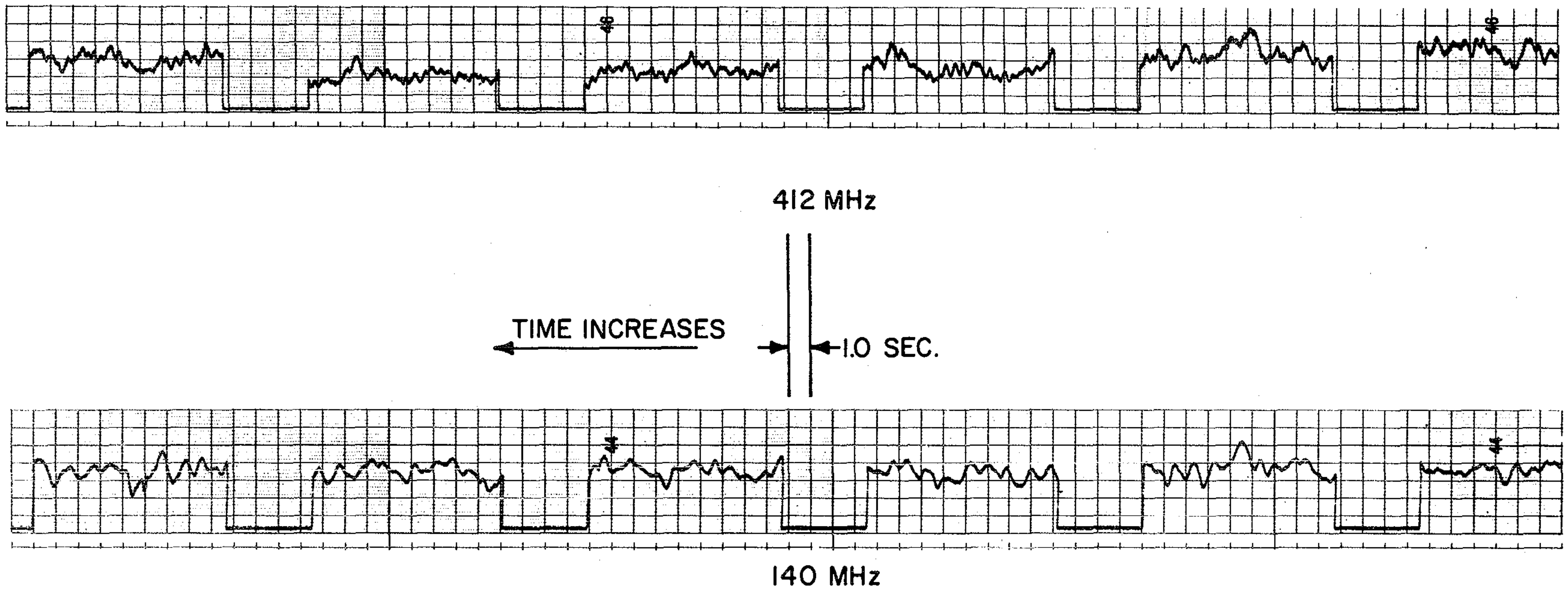


Figure 23. Recording 16 Sept. 70, 10 naut mi, 412 and 140 MHz.

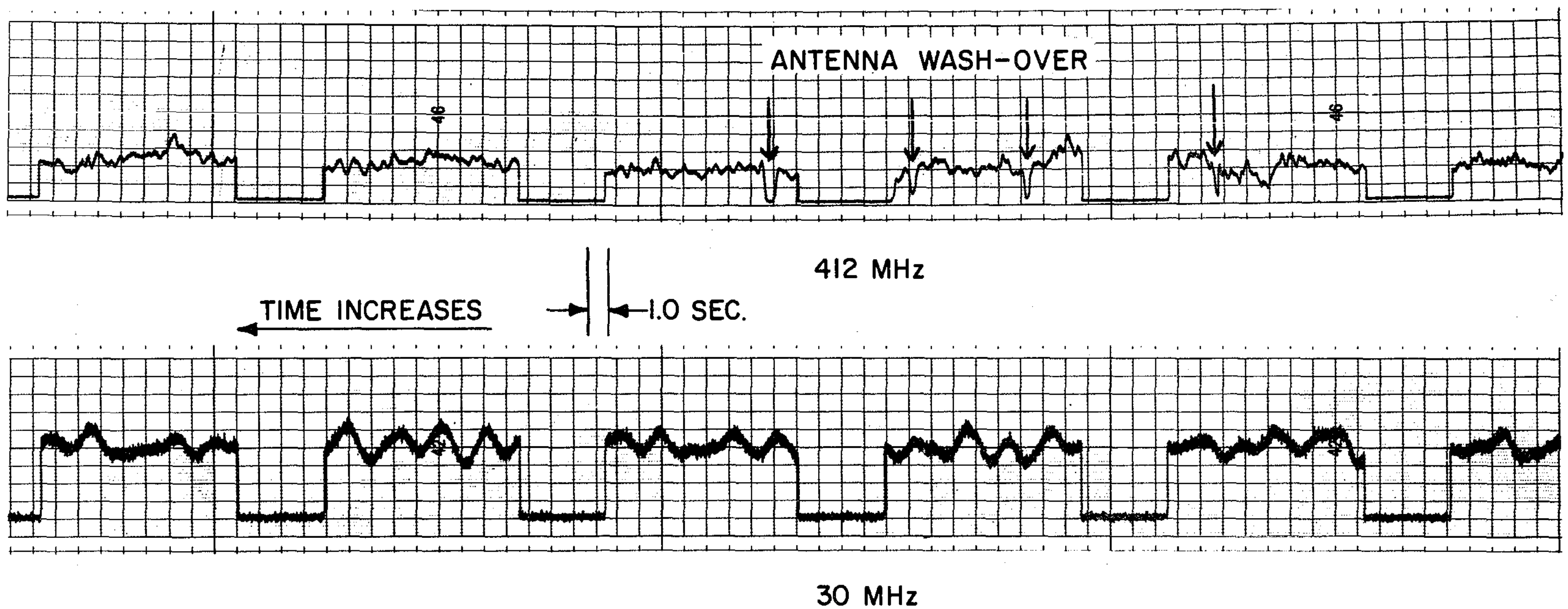


Figure 24. Recording 16 Sept 70, 10 naut mi, 412 and 30 MHz.

the more random nature of the smaller waves. In these two figures, occasional correlation of flutter at all three frequencies may be noted, at periods (2 to 4 sec) corresponding to the larger ocean waves. In general, however, fading at any two frequencies is poorly correlated.

An analysis of auto and cross-correlation of data obtained on 22 September 1970, was made by Georgia Tech, and was submitted as Attachment III of their final contract report. This is also reproduced herein as appendix C.

In contrast to figures 23 and 24, figure 25 is data also at 10 naut mi, but on a relatively calm day, 10 September 1970. The 412 MHz transmitter was not operable at this time. Repetitive swells were about two ft in height, and of a period comparable to the 30-MHz variation. Although flutter at 30 MHz is reduced, it is interesting that 140-MHz flutter is increased and is now strongly periodic. It is suggested that this may be the result of a well-defined, low-amplitude chop, which is here more evident than in the generally more turbulent conditions of the previous figures. Other calm sea data, also on 10 September 1970, are shown in figures 26 and 27 for 25 and 40 naut mi, respectively. Throughout this distance, amplitude of long-period swells remained fairly constant.

An example of anomalous propagation occasionally found may be seen in figures 26, 27, and 28 on the 140 MHz channel. This is a beat-frequency-like flutter extending over several seconds and going through a seeming zero-beat. A possible cause is multi-path interference by reflection from aircraft, since a major air traffic route crossed the propagation path, and the effect was noted only at distances beyond line-of-sight. The presence of the effect simultaneously on 412 MHz in figure 28 seems to eliminate the possibility of a co-channel interfering signal as the cause. The phenomena was not observed at 30 MHz.

Another interesting propagation anomaly is illustrated in figure 29. At a propagation range of only 2 naut mi, a heavy rain squall, similar to that shown in figure 18, passed over the transmitting terminal and included the entire propagation path. The upper record shows flutter characteristics at 140 MHz while the entire path was clear. The lower record is of the same frequency about 15 minutes later when the entire path was through heavy rain. Not only was the average path loss increased by about 10 dB, but the nature of the flutter was changed and smoothed. These conditions tended to remain after the squall moved inland and the propagation path became clear. Conclusions

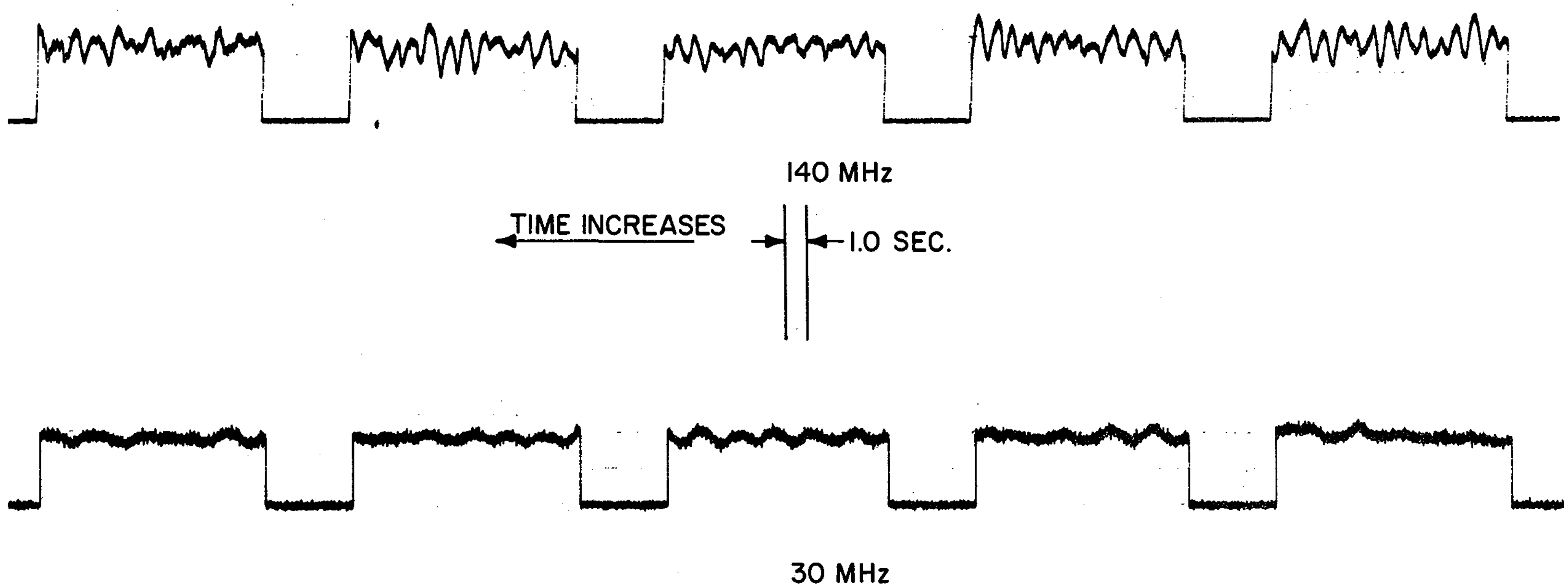


Figure 25. Recording 10 Sept 70, 10 naut mi, 30 and 140 MHz.

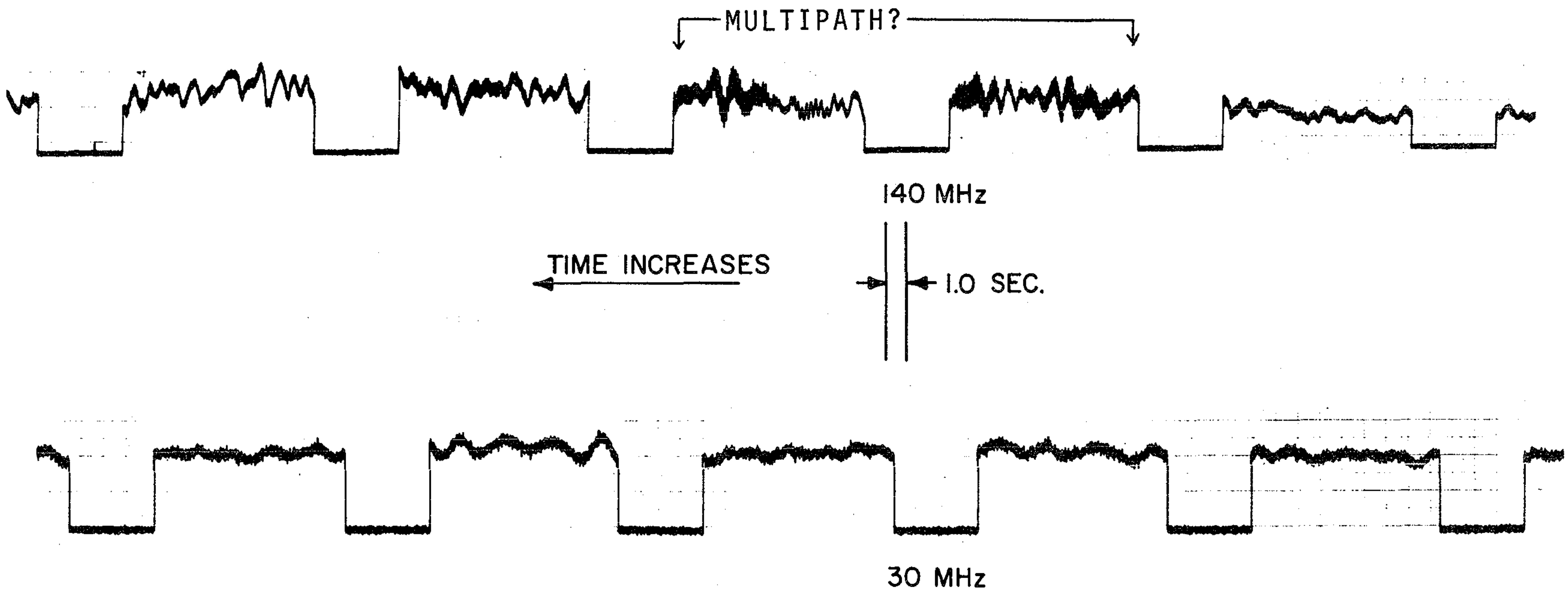


Figure 26. Recording 10 Sept 70, 25 naut mi, 30 and 140 MHz.

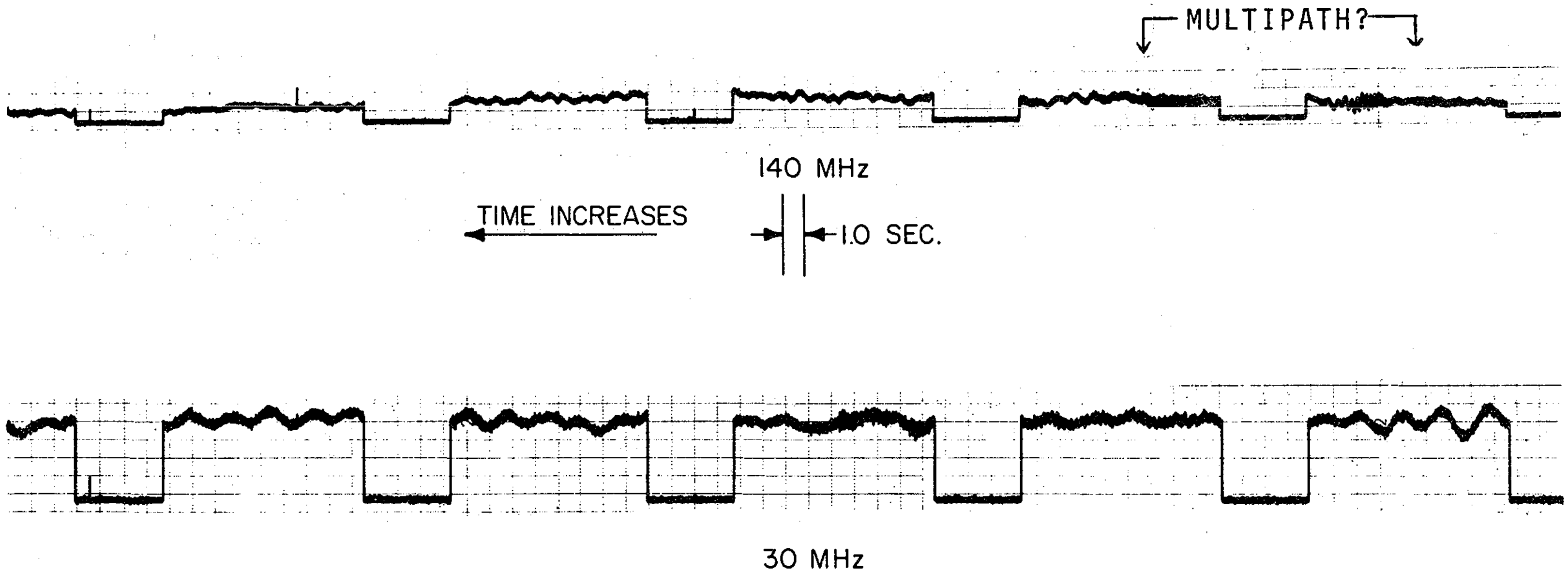


Figure 27. Recording 10 Sept 70, 40 naut mi, 30 and 140 MHz.

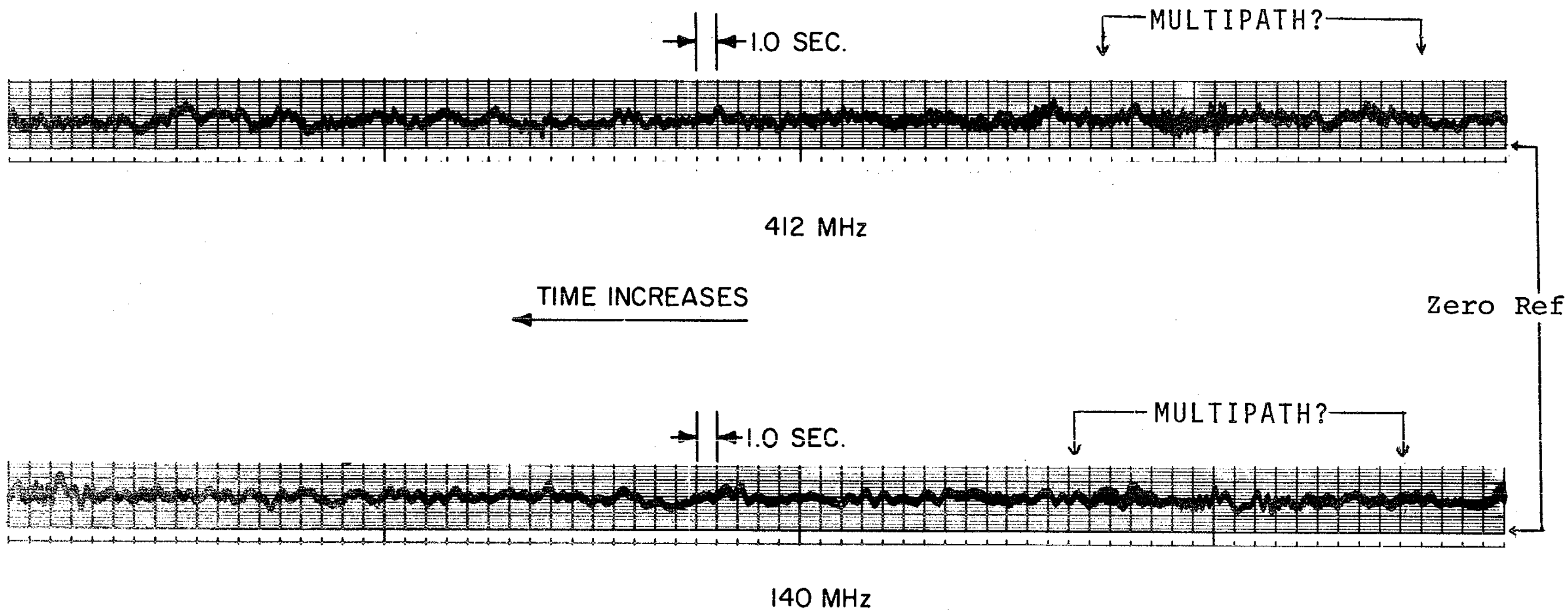


Figure 28. Recording 22 Sept 70, 15 naut mi, 140 and 412 MHz.

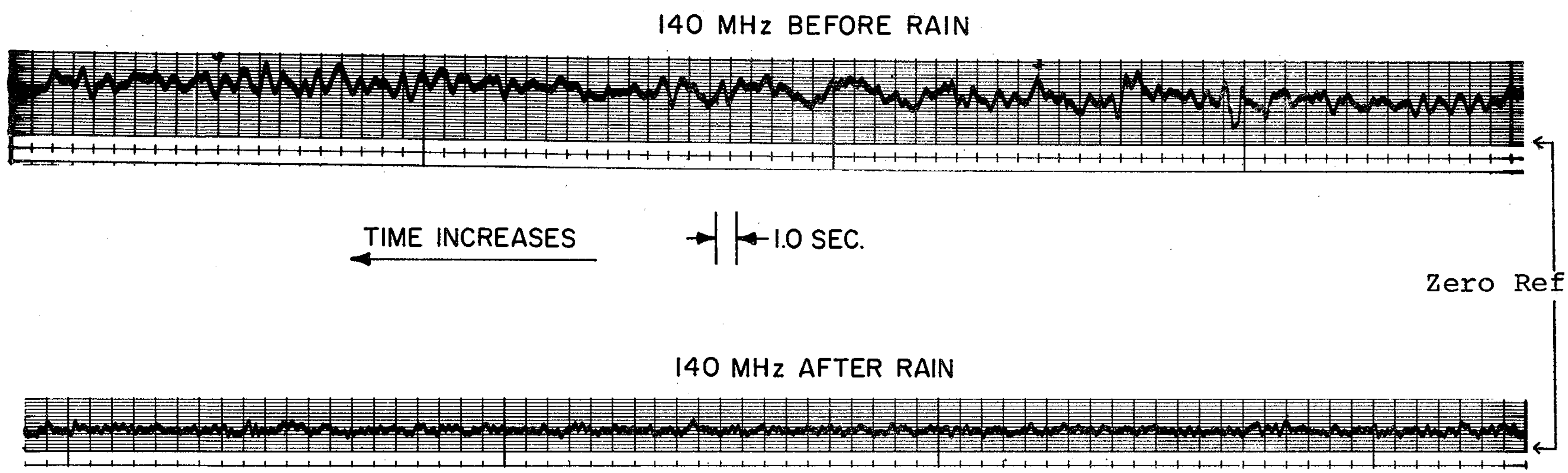


Figure 29. Recording 22 Sept 70, 2 naut mi, 140 MHz - effect of rain.

cannot be drawn from this one event; the squall changed many meteorological conditions locally. Perhaps pertinent to the reduced flutter, the heavy rain caused all but the longer-period waves to be dramatically reduced in amplitude, although the wind remained brisk. At this location, major wave amplitudes were judged to be 6 to 8 ft, and remained about the same during the rain. Unfortunately, before and after data at other frequencies were not obtained.

In order to allow computer analysis of fading data at the various frequencies, all transmissions on 22 September 1970, were made without keyed-off periods previously used for base-line determination, except for calibration purposes. This explains differences in appearance of figures 28 and 29. Zero-signal levels for each trace have been added subsequently.

In summary, tests under conditions of limited variability showed all frequencies to propagate in a generally predictable manner, assuming a standard atmospheric gradient over a 4/3 radius earth. Rapid fading, or flutter, appears to be related to wave conditions local to the float-mounted transmitting antenna. Consideration of factors such as required transmitter power, transmitting and receiving antenna size and gain, receiver equivalent noise level, and fading characteristics all lead to a choice of about 75 MHz as a preferred frequency for communication out to 20 to 50 naut mi.

A recommended system design can be tentatively worked out by interpolation from figure 22 and the following assumptions:

Range: 30 naut mi for reliable communication

Frequency: 75 MHz

Antennas: A float-mounted $\lambda/4$ vertical whip, and a 4-element Yagi at any elevation up to 50 ft or so.

Receiver: Equivalent input noise power - 120 dBm in a bandwidth of 8 kHz.

From figure 22, assume the theoretical received power at 75 MHz and a 49.2 m^2 antenna area to be -80 dBm. The 4-element Yagi, with an estimated practical gain of 10 dB over isotropic, has an effective area of 12.7 m^2, which is about 6 dB less than the 49.2 m^2 antenna. Allowing 6 dB further

reduction for "practical" differences between theoretical and measured propagation, results in a probable signal received of -92 dBm.

It is now possible to assume a radiated power of one watt (instead of the normalized 10-watt value), allow a fading range of 10 dB, and still have a received signal 8 dB above receiver noise. This design would probably be useful a large part of the time out to about 50 naut mi. With reasonable dynamic properties of the float, antenna wash-over would not be a problem except in unusually severe weather.

8. LITERATURE CITED

(1) Reed and Russell, Ultra High Frequency Propagation, John Wiley, 1953.

(2) Norton, K.A., "The Calculation of Ground Wave Field Intensity over a Finitely Conducting Spherical Earth," Proc. IRE, pp 623-639, December 1941.

(3) Final Report on Contract DAAG39-70-0053, Attachment II, page II-4 (Bibliography of 14 references on propagation), Georgia Institute of Technology.

(4) Bean, B.R., Cahoon, B.A., Sampson, C.A., and Thayer, G.D., A World Atlas of Atmospheric Radio Refractivity, U.S. Department of Commerce, ESSA Monograph #1, 1966.

(5) Blake, L.V., Apr. 24, A Note on Selection of an Atmospheric Refractivity Model for Radar Range-Height-Angle Charts, NRL Report 5626, 1961.

(6) Bean, B.R., Horn, J.D., and Ozanich, A.M., Jr., Climatic Charts and Data of the Radio Refractive Index for the United States and the World, NBS Monograph #22.

(7) Bean, B.R., and Cahoon, B.A., "The Use of Surface Weather Observations to Predict the Total Atmospheric Bending of Radio Rays at Small Elevation Angles," Correspondence, Proc. IRE (45), pp 492-496, October 1955.

(8) Bean, B.R., and Thayer, G.D., "Models of the Atmospheric Radio Refractive Index," Proc. IRE (47) pp 740-755, May 1959.

(9) Gray, R.E., "Tropospheric Scatter Propagation and Meterological Conditions in the Caribbean," IRE Trans on Antennas and Propagation, AP-9, pp 492-496, Sept 1961.

(10) McPetric, J.S., and Starnecki, B., "Low Level Atmospheric Ducts," Nature, Vol. 162, p 818, November 20, 1948.

(11) Anderson, L.J., and Gossard, E.E., "Prediction of Oceanic Duct Propagation from Climatological Data," IRE Transactions on Antennas and Propagation, AP-3, No. 4, pp 163-167, October 1955. (Also NEL Report 654, 14 December 1955).

(12) Gossard, E.E., Radio Refraction by the Marine Layer and its Effect on Microwave Propagation, NEL Report 1240, September 21, 1964.

(13) PeKeris, C.L., "Wave Theoretical Interpretation of Propagation of 10-centimeter and 3-centimeter Waves in Low-Level Ocean Ducts," Proc. IRE (35), pp 453-462, May, 1947.

(14) Anderson, L.J., and Gossard, E.E., "The Effect of the Ocean Duct on Microwave Propagation," pp 695-700, October 1953.

(15) Randall, D.L., and Shulkin, M., Survey of Meterological Instruments used in Tropospheric Propagation Investigations, NBS Central Radio Propagation Laboratory Report No. CRPL-2-1.

(16) Richards, E.G., "The Estimation of Transmission Loss in the Trans-horizon Region," Proc IEE, pp 177-183, January 1958.

(17) The Physical Society and the Royal Meterological Society, Meterological Factors in Radio-Wave Propagation, Report of Conference held 8 April 1946.

(18) Freres, C.H., Sailors, D.B., and Taylor, T.L., Radio Propagation over the Sea in the 2-to-10 MHz Range, NELC Report 1526, November 21, 1967.

APPENDIX A. SCHEMATICS OF TRANSMITTING AND RECEIVING EQUIPMENT.

This appendix contains for record purposes the following schematics of transmitting and receiving equipment constructed by Harry Diamond Laboratories for radio-wave propagation measurements over sea water.

Figure A-1 - Transmitter power supply

Figure A-2 - 30-MHz transmitter

Figure A-3 - 140-MHz transmitter

Figure A-4 - 412-MHz transmitter

Figure A-5 - 140-MHz receiving converter

Figure A-6 - 412-MHz receiving converter

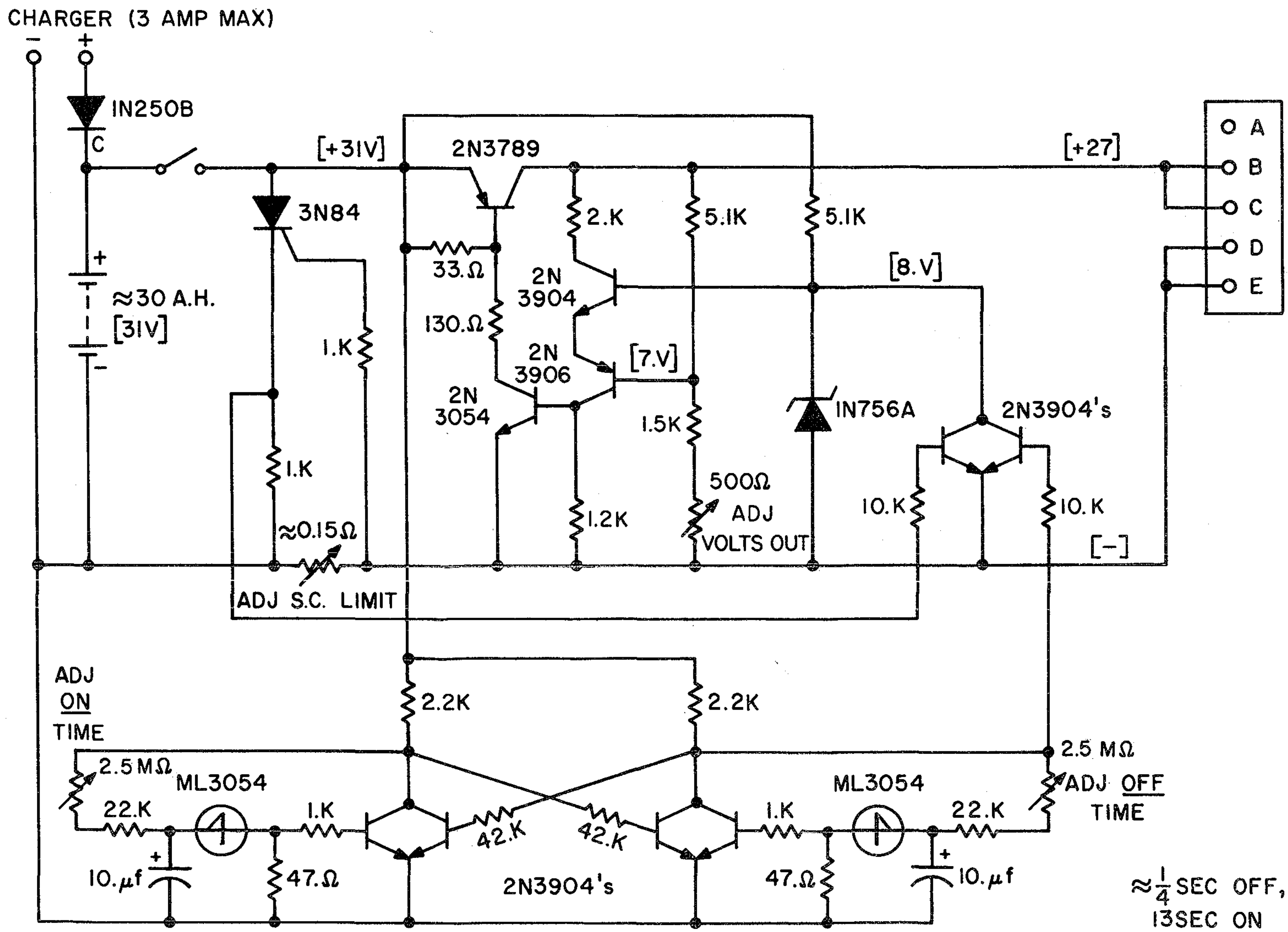
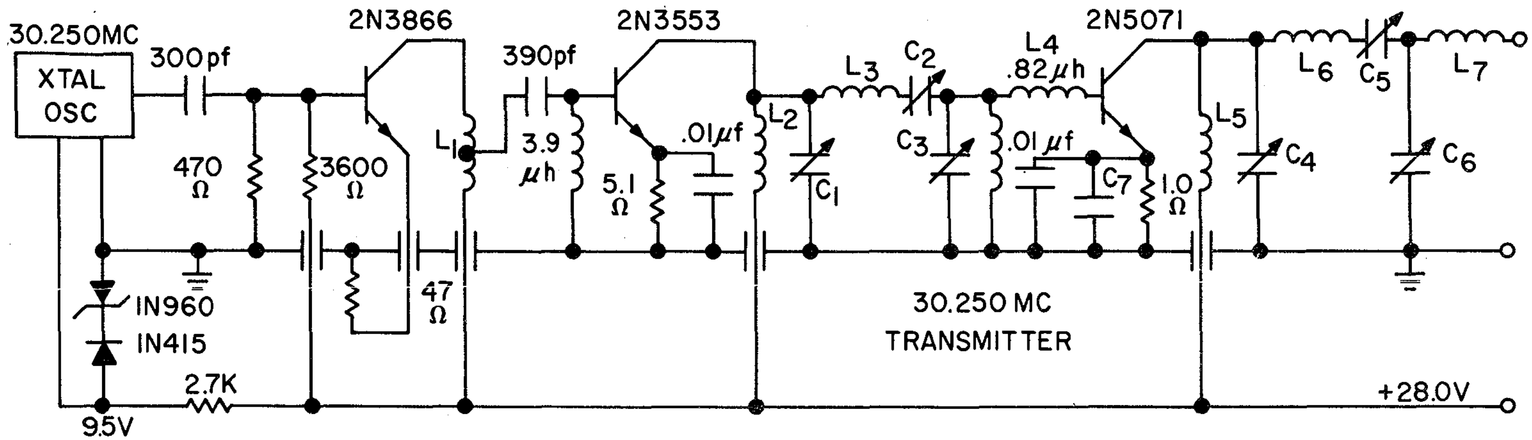


Figure A-1. Transmitter power supply.



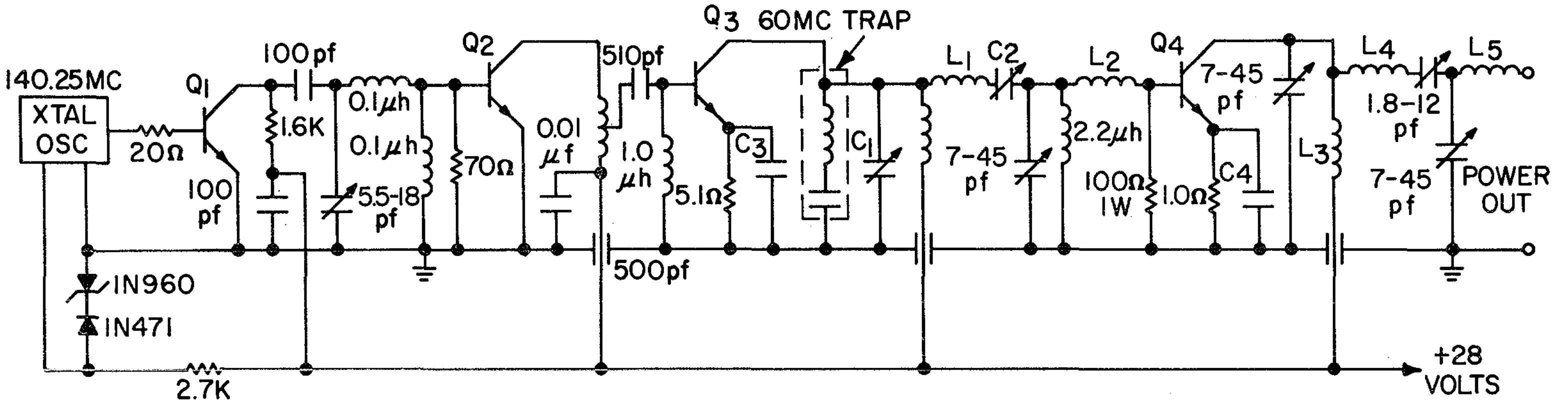
L_1 = ¼ inch Diam. Form, 10 turns #22 wire, Tap Point @ 2.0 turns from bottom.
L_2 = 6.0 turns #14 wire. Form Diam. = 5/16 inch.
L_3 = 20 turns #22 wire. Form Diam. = 3/8 inch.
L_4 = 6.0 turns #22 wire. Form Diam. = 3/8 inch.
L_5 = 6.0 turns #14 wire. Form Diam. = 3/8 inch.

NOTE

All Feedthroughs 1000pf unless otherwise stated.

L_6 = 22 turns #22 wire. Form Diam. = 3/8 inch.
L_7 = 6.0 turns #14 wire. Form Diam. = 3/8 inch.
C_1, C_3, C_4, C_6 = ARCO 463 = 9.0 to 180pf.
C_2 & C_5 = 2.2 to 34.0pf.
C_7 = CONSTRUCTED From 2 Brass Plates and 2 Mica Sheets. Size of Mica Sheets = 2 Mils Thick, 2½ inches long and 1½ inches wide. Size of brass plates = 0.040 inch thick, 2 3/8 inches long and 1 3/8 inches wide.

Figure A-2. 30 MHz transmitter.



Q_1 = MMT-918
Q_2 = 2N3866
Q_3 = 2N3553
Q_4 = 2N5016
L_1 = 6.0 turns #22 wire. $\frac{1}{4}$ inch Diam. Form.
L_2 = 4.0 turns #18 wire. $\frac{5}{16}$ inch Diam. Form.
L_3 = 5.0 turns #18 wire. $\frac{5}{16}$ inch Diam. Form.
L_4 = 6.0 turns #22 wire. $\frac{1}{4}$ inch Diam. Form.
L_5 = 3.0 turns #18 wire. $\frac{5}{16}$ inch Diam. Form.

C_1 = 7-45pf.
C_2 = 1.8 - 12pf.
C_3 & C_4 = Constructed from 2 Brass Plates and 2 Mica Sheets.
Size of Mica Sheets = 2 Mils thick, $2\frac{1}{2}$ inches long, and $1\frac{1}{2}$ inches wide.
Size of Brass Plates - 0.040 inch thick, $2\frac{3}{8}$ inches long and $1\frac{3}{8}$ inches wide.

Figure A-3. 140 MHz transmitter.

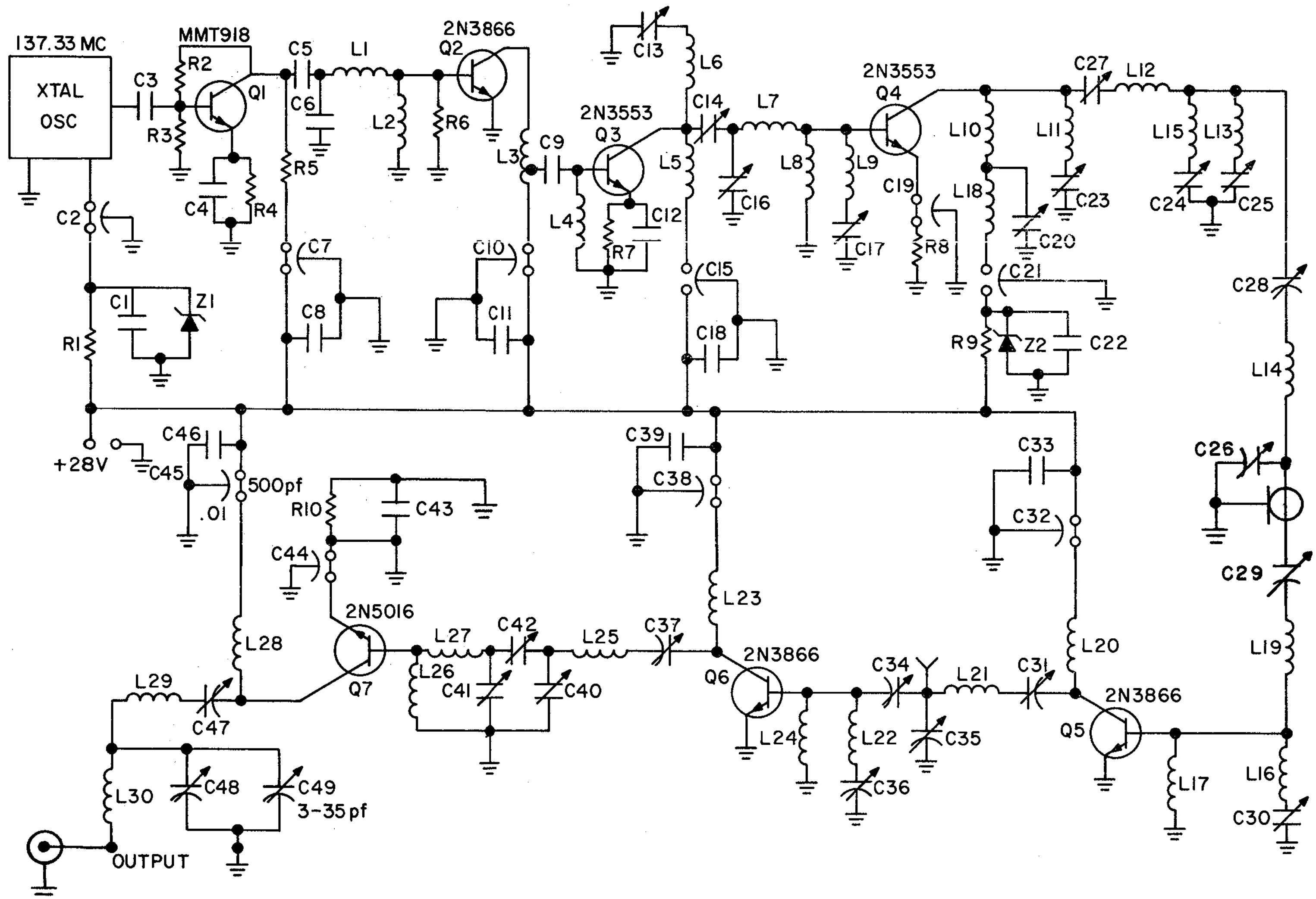
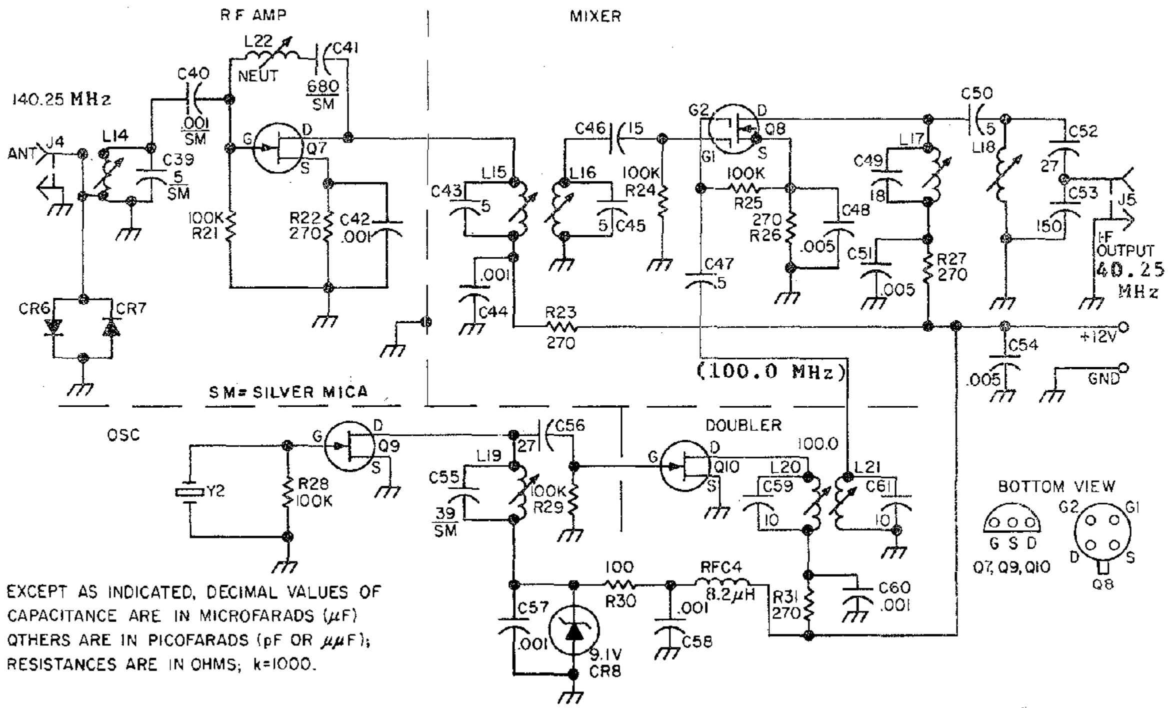


Figure A-4. 412 MHz transmitter.



Circuit of the 2-meter converter. Resistors are ½-watt composition. Capacitors, unless otherwise noted, are disk ceramic.

CR_6, CR_7 - 1N914 or equivalent.

CR_8 - 9.1-volt, 1-watt Zener diode (Motorola HEP-104 or equivalent).

J_4 - BNC or SO-239-type chassis connector.

J_5 - Phono connector.

L_{14} - 4 turns No. 24 enamel to occupy ⅜ inch on J.W. Miller 4500-4 iron-slug form. Tap 1 turn from ground end.

L_{15}, L_{16}, L_{19} - 5 turns No. 24 enamel to occupy ⅜ inch on same-type Miller form as L_{14}.

L_{17}, L_{18} - 15 turns No. 24 enamel wire, close-wound, on J. W. Miller 4500-2 iron-slug form.

L_{20}, L_{21} - Same as L_{14}, but no tap.

L_{22} - 9 turns No. 30 enamel, close-wound, on J.W. Miller 4500-2 iron-slug form (J. W. Miller Co., 19070 Reyes Ave., Compton, Cal. 90221; write for catalog and prices).

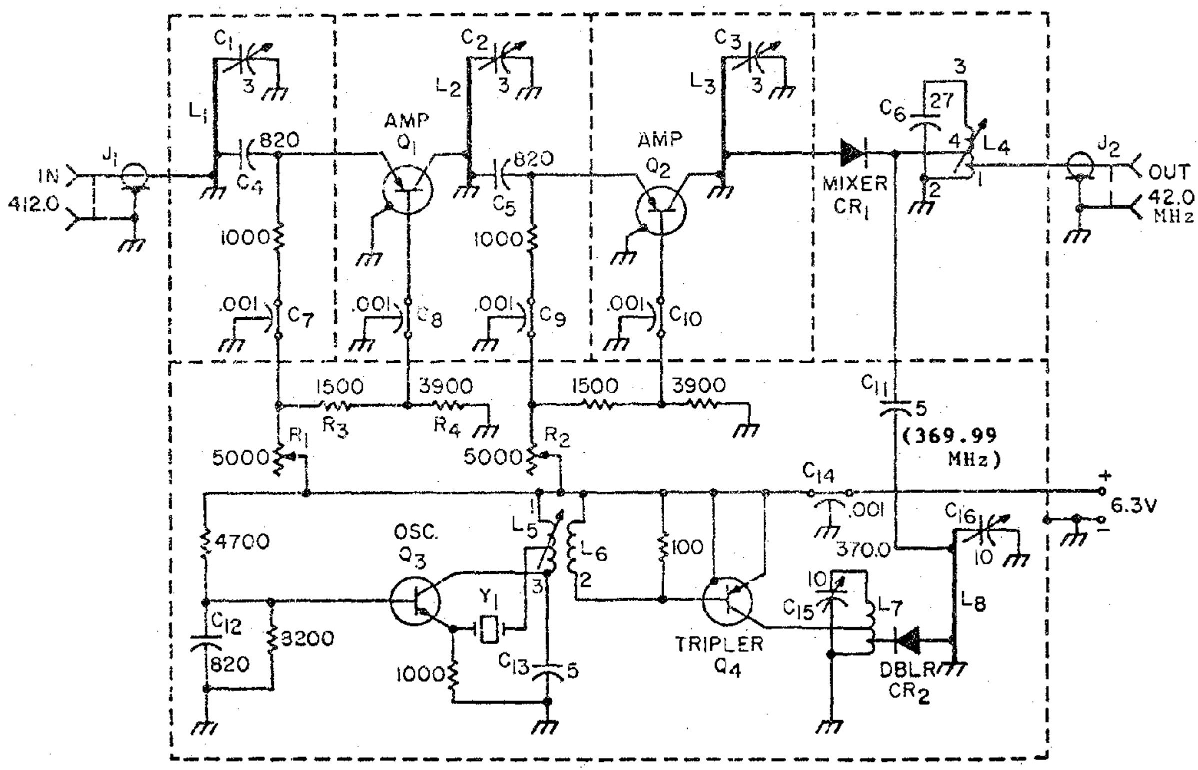
Q_7, Q_9, Q_{10} - Junction FET, Motorola MPF102 (2N4416 suitable).

Q_8 - Dual-gate MOSFET, Motorola MFE3008 (RCA 3N141 also suitable).

RFC_4 - 8.2-µH miniature rf choke (James Millen 34300-8.2).

Y_2 - 50.0 3rd-overtone crystal (International Crystal Co. type EX).

Figure A-5. 140 MHz receiving converter.



C_1, C_2, C_3 - 0.5- to 3-pf. ceramic or glass trimmer (Centralab 829-3).
C_4, C_5, C_{12} - 820-pf. disk ceramic (0.001-μf. also suitable).
C_7, C_8, C_9, C_{10}, C_{14} - 0.001-μf. feedthrough capacitor (Erie 654-017102K. Centralab FT-1000 also suitable).
C_6 - 27-pf. dipped mica.
C_{11}, C_{13} - 5-pf. dipped mica.
C_{15}, C_{16} - 1- to 10-pf. ceramic or glass trimmer (Centralab 829-10).
CR_1 - U.h.f. mixer diode (Sylvania 1N82A).
CR_2 - Silicon signal diode (GE 1N4009).
J_1, J_2 - Coaxial fitting.
L_1, L_2, L_3, L_8 - No. 12 wire, 2½ inches long. Tap L_1 at 1 and 1½ inches, L_2 at ½ and 1 inch, L_3 at ¾ and 1¼ inches, L_8 at ½ and 1¼ inches.
L_4 - No. 26 enamel wound as per text on ⅜ inch iron-slug form (CTC 1534-2-2, slug coded red).
L_5, L_6 - No. 26 enamel wound as per text on ⅜ inch iron-slug form (CTC 1534-4-2, slug coded white).
L_7 - 4½ turns No. 16 enamel, ⅜ inch diam., ⅝ inch long. Tap at 1 and 2 turns.
Q_1, Q_2, Q_3, Q_4 - See text.
R_1, R_2 - 5000-ohm miniature control. All other resistors ½ watt or less, values as marked.
R_3, R_4 - for text reference.
Y_1 - 5th-overtone crystal, 61.667 MHz (International Crystal Co.).

Figure A-6. 412 MHz receiving converter.

APPENDIX B. METEOROLOGICAL DATA AND PROPAGATION BIBLIOGRAPHY

(Attachment II of final report on contract DAAG39-70-0053, 17 Feb. 1971.)

The data assembled here are provided as partial documentation of the atmospheric propagation conditions during the series of experiments conducted at Boca Raton, Florida, in September 1970. The Bibliography is intended to provide a guide to some of the more applicable literature.

The data consist of twice-daily radiosonde readings obtained by the National Weather Service at Miami International Airport, daily weather summaries (both local and Weather Service, and graphs of refractivity data from the radiosonde flights. Detailed near-surface data are not currently available for the September period; however, efforts are still underway to obtain additional information.

Since the index of refraction of air is primarily a function of total pressure, temperature, and partial pressure of water vapor in the air, it is convenient to make use of an empirical relation for the index of refraction, n, in terms of these quantities in order to investigate the effects of refraction on radio propagation. A suitable empirical relation is (Reference 26)

$$n = 1 + \left(77.6 \frac{P}{T} + 3.73 \times 10^5 \frac{e}{T^2}\right) \times 10^{-6}, \qquad (1)$$

where P is the total pressure in millibars, e is the partial pressure of water vapor in millibars, and T is the absolute temperature in degrees Kelvin.

Although the second and third terms contribute only a few hundred parts per million to the refractive index, it is the variation of these terms with heights which brings about the "bending" of the radio waves. Thus, it is useful to define a quantity N, the refractivity, which is related to n by

$$N = (n-1) \times 10^6 \quad , \qquad (2)$$

or

$$N = 77.6 \frac{P}{T} + 3.73 \times 10^5 \frac{e}{T^2} \quad . \qquad (3)$$

A number of variants to N have been used for various practical applications (Reference 26). One form of modified refractive index which has been widely used and is used here in Figure II-1 through II-3 is M, defined as

$$M = N_h + 0.048\ h \quad , \tag{4}$$

where N_h is the value of refractivity at any height h in feet. When the M-gradient is zero, the ray curvature is zero in the flat-earth case. This is another way of saying that when the N-gradient is minus 48 units per 1000 feet, the ray has the same curvature as the earth.

Another variant which is often used is the B-modification, where B is defined as

$$B = N_h + 0.012\ h \quad , \tag{5}$$

where N_h and h are as defined above. This modification is used to illustrate departures from "standard" atmosphere, and this is a logical consequence of the four-thirds earth radius concept of the standard atmosphere definition.

The radiosonde data of Table II-1 were reduced to N-units by the use of Equation 3 and tables from the Handbook of Chemistry and Physics (Chemical Rubber Corporation, Edition 49, 1968) and the Smithsonian Meteorological Tables, Sixth Revised Edition, Robert J. List (Publication 4014, Smithsonian Institution, Washington, D. C.). The data are plotted in Figures II-1A, II-2, and II-3 as M-units in order to explore the possibility of ducting levels (i.e., vertical lines). The graph in Figure II-4 is reproduced from Reference 26 and makes use of B-units. The lines shown in Figure II-1B are presented as graphical aids to the intepretation of the radiosonde data in the other figures. The labels on the lines of Figure II-1B show the effective earth radii which would result from M-profiles of the indicated slopes. These slopes should be interpreted as showing a general trend rather than an actual height dependence of M.

The M-profiles shown in Figures II-1A, II-2, and II-3 are believed to be generally descriptive of the elevated atmospheric conditions which actually existed at the Boca Raton Field Site during the measurement period. The surface point, however, probably does not accurately represent the surface conditions at the Field Site, since these data were taken inland near the Miami airport. Inspection of Figure

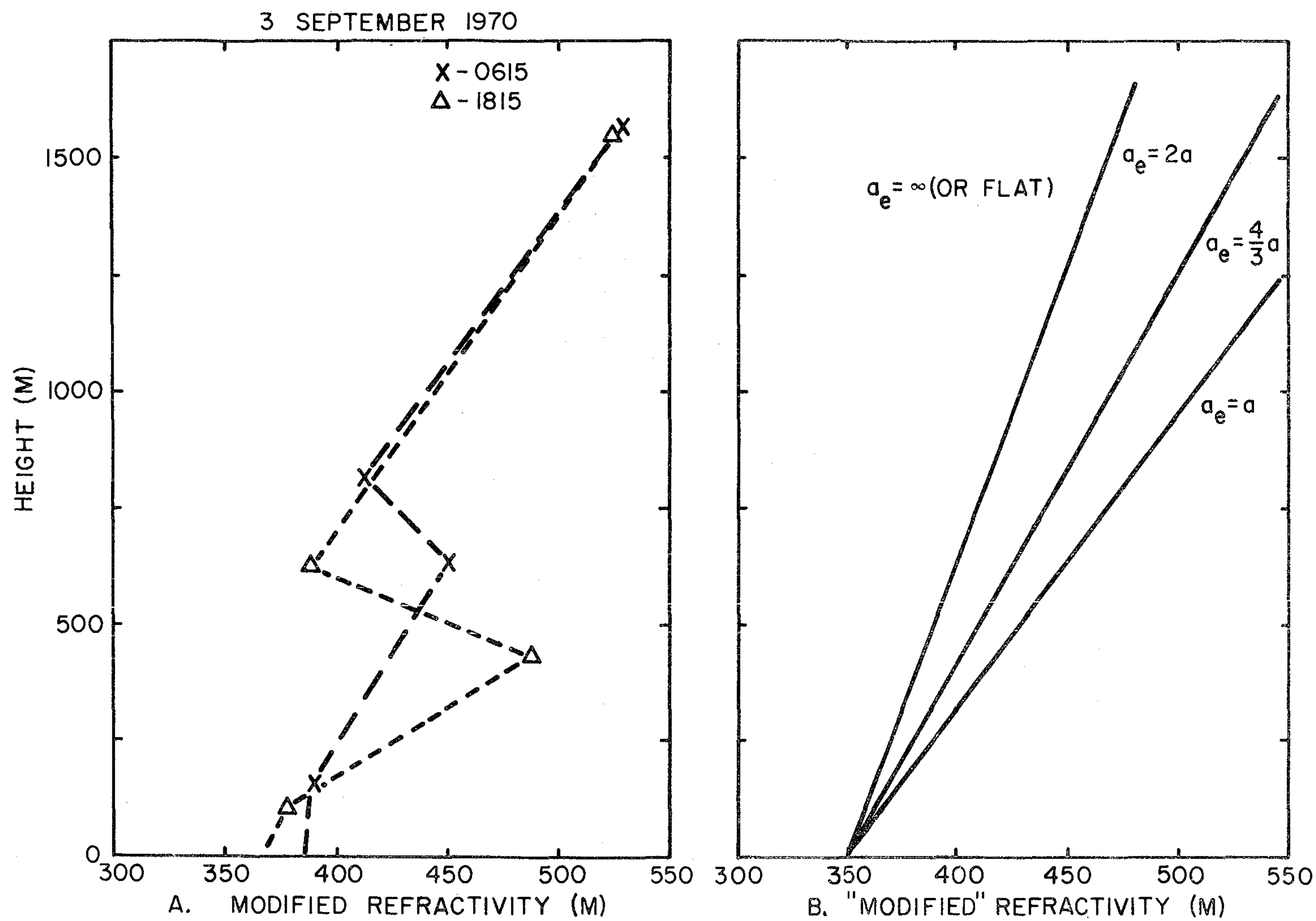


Figure II-1. Modified refractivity versus height for 3 September and for several assumed effective earth radii.

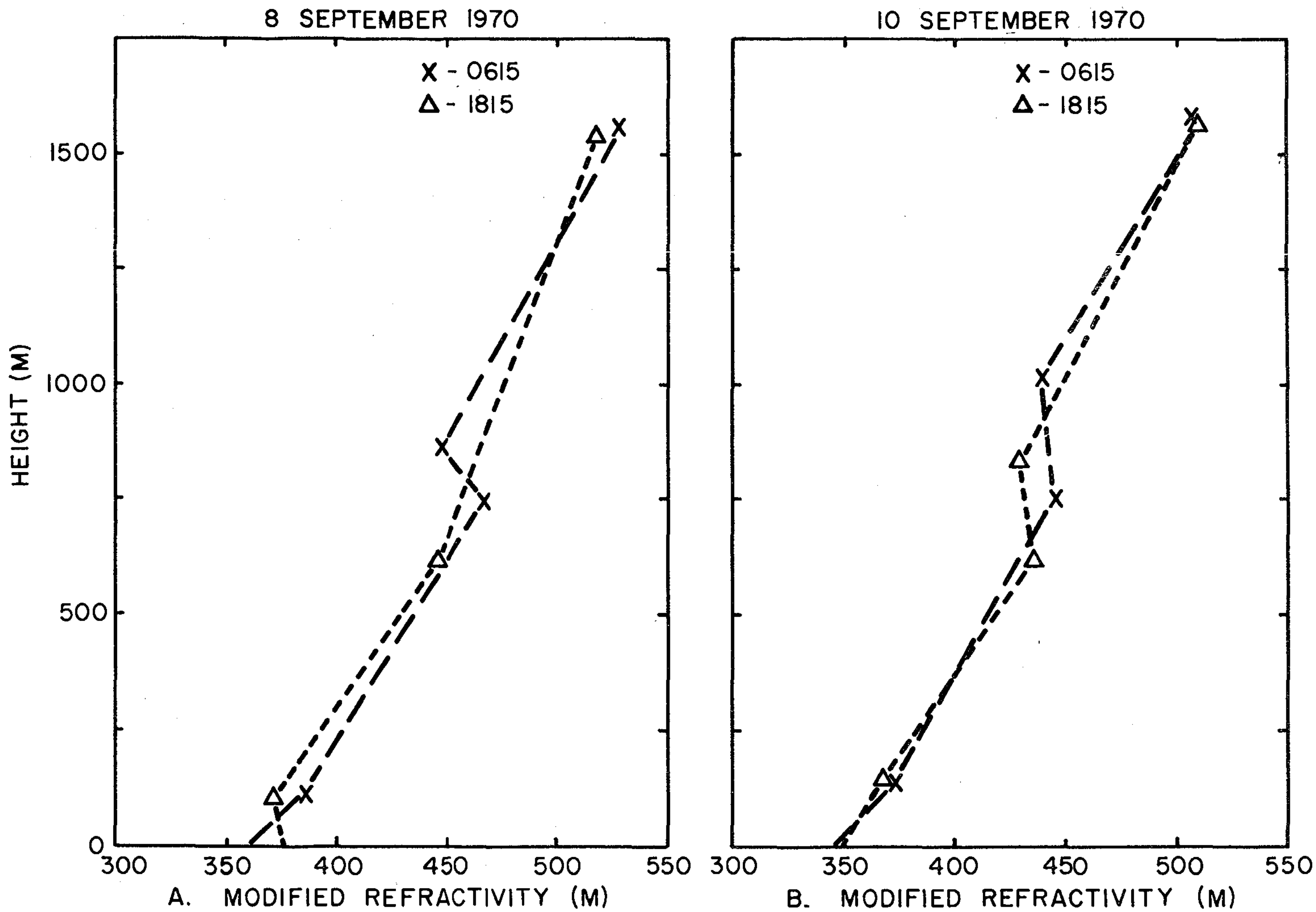


Figure II-2. Modified refractivity versus height for 8 and 10 September.

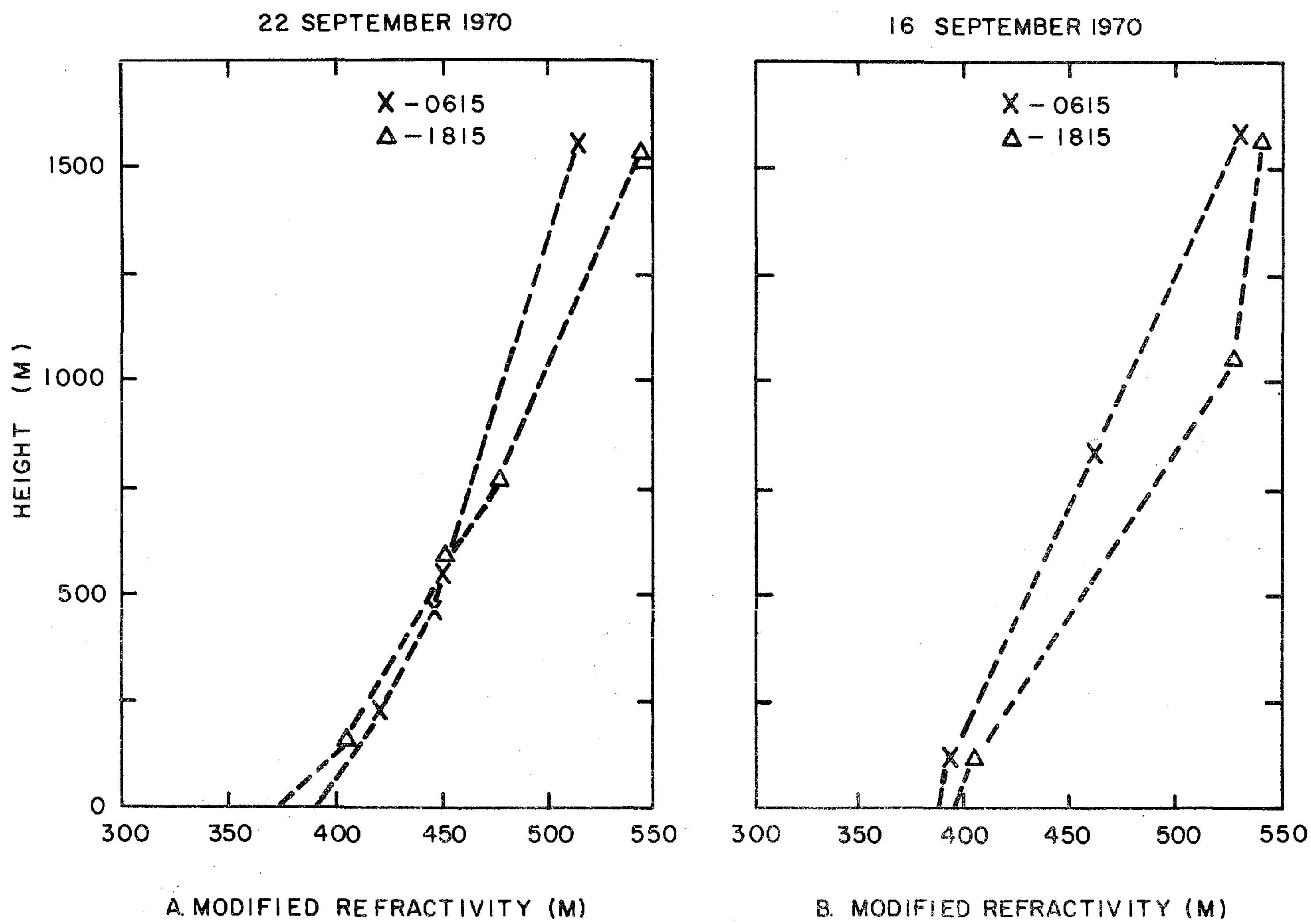


Figure II-3. Modified refractivity versus height for 16 and 22 September.

II-4 shows that the region of interest extends to heights of several hundred meters; thus, more information is needed to actually define the near-surface refractivity. The data in Table II-2 are included to provide some information about the air-water interface which may be of value in defining the lower region. Reference 26 provides an approach to defining the height and strength of the surface evaporation layer from knowledge of air-water temperature difference and wind speed. Another possibility would be to refine the surface point of the M-profiles with the aid of the data of Table II-2. Neither of these approaches has been investigated.

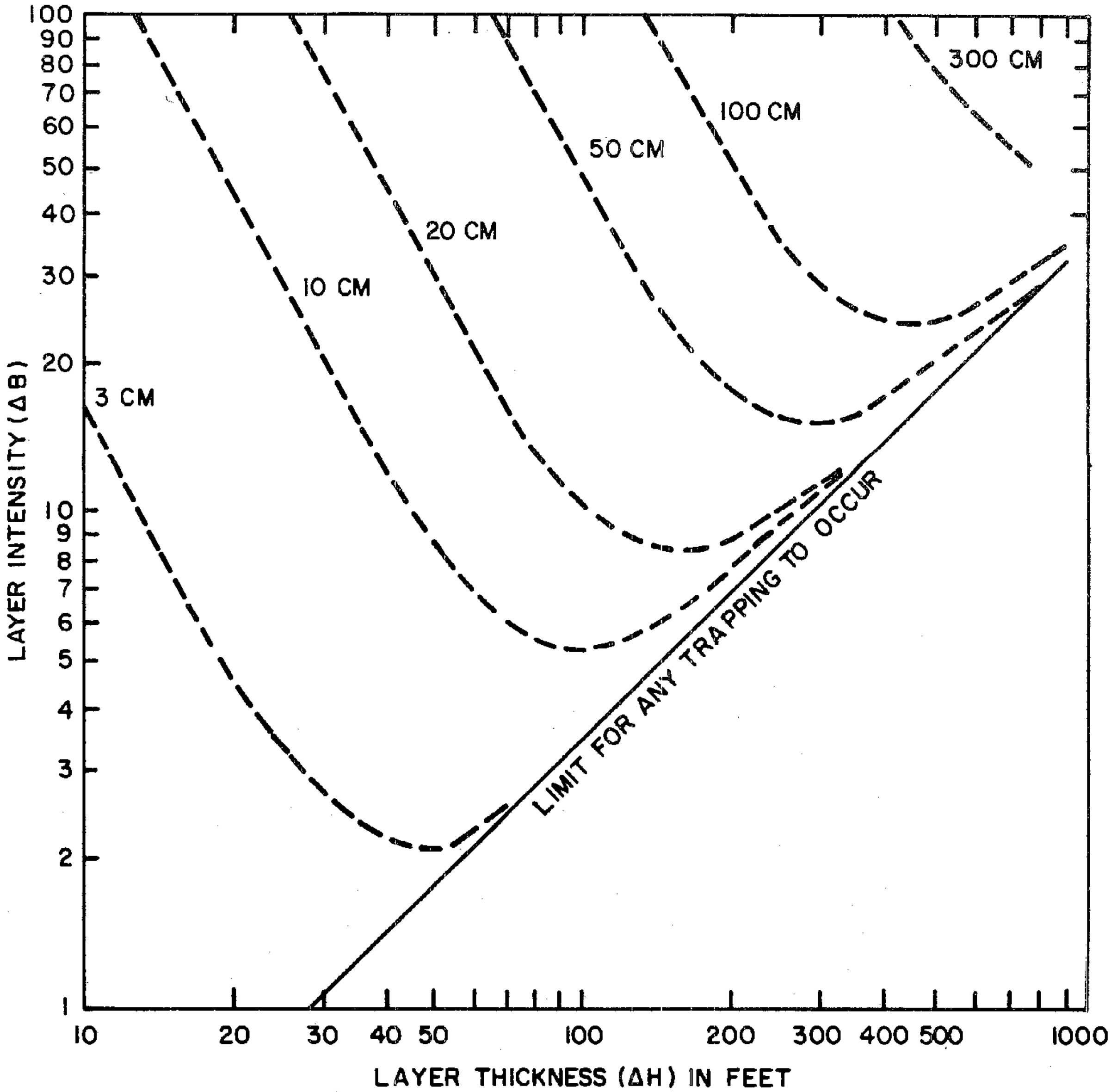


Figure II-4. Limits for trapping as a function of layer thickness and intensity. (from reference 26, page 163).

TABLE II-1. RADIOSONDE DATA FOR SEPTEMBER 1970. (MIAMI, FLA.)

DATE/TIME	HEIGHT (Meters)	PRESSURE (mb)	DRY BULB TEMP (°C)	DEW POINT (°C)	DEPRESSION (°C)	REFRACTIVITY (N Units)
3 Sept. 70, 0615 EST	0	1017	27.2	---	2.2	386.7
	155	1000	27.2	---	4.0	365.8
	---	947	22.4	---	1.5	351.1
	---	931	22.4	---	9.0	285.4
	1571	850	17.4	---	5.0	275.6
3 Sept. 70, 1815 EST	0	1017	28.8	---	4.9	367.7
	150	1000	26.2	---	4.4	354.9
	---	968	23.8	---	2.2	417.8
	---	948	23.8	---	9.0	291.2
	1563	850	17.6	---	5.6	272.3
8 Sept. 70, 0615 EST	0	1013	25.0	---	3.6	360.1
	121	1000	26.0	---	3.0	367.7
	---	937	21.6	---	0.9	349.7
	---	925	21.6	---	4.9	312.2
	1555	850	16.8	---	3.3	285.1
8 Sept. 70, 1815 EST	0	1013	29.4	---	4.4	375.9
	119	1000	27.0	---	5.0	353.7
	---	949	23.0	---	1.9	349.0
	1535	850	16.8	---	4.8	276.2
10 Sept. 70, 0615 EST	0	1017	27.8	---	5.0	347.8
	150	1000	26.6	---	3.2	351.0
	---	934	21.2	---	1.9	326.2
	---	909	21.2	---	7.0	280.5
	1567	850	17.0	---	5.0	262.3

TABLE II-1. RADIOSONDE DATA FOR SEPTEMBER 1970. (MIAMI, FLA.) (Continued)

DATE/TIME	HEIGHT (Meters)	PRESSURE (mb)	DRY BULB TEMP (°C)	DEW POINT (°C)	DEPRESSION (°C)	REFRACTIVITY (N Units)
10 Sept. 70, 1815 EST	0	1017	29.4	---	6.0	347.6
	150	1000	27.4	---	4.9	343.6
	---	949	23.0	---	1.5	337.1
	---	927	21.4	---	5.6	299.2
	1567	850	18.2	---	5.7	262.8
15 Sept. 70, 0615 EST	0	1015	26.1	23.6	---	298.5
	136	1000	26.1	24.4	---	386.3
	1551	850	17.2	14.6	---	300.6
15 Sept. 70, 1815 EST	0	1015	25.6	24.0	---	388.0
	133	1000	24.7	23.0	---	378.2
	430	967	24.5	21.9	---	361.5
	1548	850	16.5	14.5	---	301.0
16 Sept. 70, 0615 EST	0	1018	26.7	24.5	---	390.2
	159	1000	26.5	22.5	---	371.0
	830	925	20.5	17.3	---	328.7
	1578	850	17.3	10.7	---	283.2
16 Sept. 70, 1815 EST	0	1017	27.8	25.6	---	396.1
	157	1000	26.9	23.5	---	378.7
	1060	902	20.3	15.7	---	358.9
	1576	850	17.7	12.8	---	292.0
17 Sept. 70, 0615 EST	0	1017	26.1	25.1	---	395.0
	157	1000	26.6	25.4	---	391.6
	1090	899	19.0	18.5	---	330.5
	1340	873	17.9	12.5	---	295.2
	1569	850	16.5	13.2	---	294.8

TABLE II-1. RADIOSONDE DATA FOR SEPTEMBER 1970. (MIAMI, FLA.) (Continued)

DATE/TIME	HEIGHT (Meters)	PRESSURE (mb)	DRY BULB TEMP (°C)	DEW POINT (°C)	DEPRESSION (°C)	REFRACTIVITY (N Units)
10 Sept. 70, 1815 EST	0	1017	29.4	---	6.0	347.6
	150	1000	27.4	---	4.9	343.6
	---	949	23.0	---	1.5	337.1
	---	927	21.4	---	5.6	299.2
	1567	850	18.2	---	5.7	262.8
15 Sept. 70, 0615 EST	0	1015	26.1	23.6	---	298.5
	136	1000	26.1	24.4	---	386.3
	1551	850	17.2	14.6	---	300.6
15 Sept. 70, 1815 EST	0	1015	25.6	24.0	---	388.0
	133	1000	24.7	23.0	---	378.2
	430	967	24.5	21.9	---	361.5
	1548	850	16.5	14.5	---	301.0
16 Sept. 70, 0615 EST	0	1018	26.7	24.5	---	390.2
	159	1000	26.5	22.5	---	371.0
	830	925	20.5	17.3	---	328.7
	1578	850	17.3	10.7	---	283.2
16 Sept. 70, 1815 EST	0	1017	27.8	25.6	---	396.1
	157	1000	26.9	23.5	---	378.7
	1060	902	20.3	15.7	---	358.9
	1576	850	17.7	12.8	---	292.0
17 Sept. 70, 0615 EST	0	1017	26.1	25.1	---	395.0
	157	1000	26.6	25.4	---	391.6
	1090	899	19.0	18.5	---	330.5
	1340	873	17.9	12.5	---	295.2
	1569	850	16.5	13.2	---	294.8

TABLE II-1. RADIOSONDE DATA FOR SEPTEMBER 1970. (MIAMI, FLA.) (Continued)

DATE/TIME	HEIGHT (Meters)	PRESSURE (mb)	DRY BULB TEMP (°C)	DEW POINT (°C)	DEPRESSION (°C)	REFRACTIVITY (N Units)
22 Sept. 70, 1815 EST	0	1014	28.9	23.3	---	376.5
	123	1000	26.8	24.5	---	385.5
	790	927	21.5	21.3	---	351.5
	1538	850	17.5	15.4	---	303.3
23 Sept. 70, 0615 EST	0	1014	25.0	24.5	---	392.2
	129	1000	26.6	23.6	---	379.2
	700	938	20.5	19.5	---	345.1
	1080	898	20.0	12.2	---	341.8
	1545	850	17.7	6.0	---	266.4

TABLE II-2. AIR-WATER TEMPERATURES FOR SELECTED DAYS IN SEPTEMBER 1970

DATE	AIR TEMPERATURE (°F) Min.	Max.	Avg.	SURF* TEMPERATURE (°F)
2 Sept.	81	86	84	88
3 Sept.	82	87	85	88
4 Sept.	80	88	84	88
7 Sept.	81	87	84	87
8 Sept.	79	88	84	89
9 Sept.	79	86	83	88
10 Sept.	81	87	84	88
11 Sept.	80	86	83	90
15 Sept.	73	83	78	85
16 Sept.	80	85	83	85
17 Sept.	73	85	79	85
21 Sept.	73	84	79	85
22 Sept.	74	85	80	85
23 Sept.	79	85	82	85

*Measured at 3 P.M. EST.

Bibliography of Propagation Papers

1. DuCastal, F. - Tropospheric Radiowave Propagation Beyond the Horizon, Pergamon Press, New York (1966).

2. Norton, K. A. - The calculation of ground wave field intensity over a finitely conducting spherical earth. Proc. I.R.E., 29, 623-639, 1941.

3. Wickizer, G. S., Braaten, A. M. - Propagation studies on 45, 474 and 2800 Mc, within and beyond the radio horizon. Proc. I.R.E., 35, 670-679, 1947.

4. Rocco, M. D., Smyth, J. B. - Diffraction of HF radio-waves around the earth. Proc. I.R.E., 35, 891-905, 1947.

5. Bullington, K. - Radio propagation of frequencies above 30 Mc. Proc. I.R.E., 35, 1112-1136, 1947.

6. Wainich, A. H. - Ultrashort wave propagation beyond the horizon. Proc. I.R.E., 35, 1334-1338, 1947.

7. Bullington, K. - Propagation of UHF and SHF waves beyond the horizon. Proc. I.R.E., 38, 1221-1222, 1950.

8. Megaw, E. C. S. - The scattering of electromagnetic waves by atmospheric turbulence. Nature, London, 166, 1100-1104, 1950.

9. Saxton, J. A. - The propagation of metre radio waves beyond the horizon. Proc. I.E.E., III, 98, 360-378, 1951.

10. Albright, W. G., Jordan, E. C., Toman, K. - Meteorological effects on VHF propagation. Trans. I.R.E., AP, 20-30, 1952.

11. Feinstein, J. - The role of partial reflection in tropospheric propagation beyond the horizon. Trans. I.R.E., AP, 2-8, 1952; 101-111, 1952.

12. Spencer, C. W. - Radiowave propagation of 89 Mc in relation to synoptic conditions. Met. Mag., 81, 206-216, 1952.

13. Bullington, K. - Radio transmission beyond the horizon in the 40-4000 Mc band. Proc. I.R.E., 41, 132-135, 1953.

14. Randall, D. L. - A study of the meteorological effects on radio propagation at 93.6 Mc between Richmond, Virg., and Washington, D.C. Bull. Am. Met. Soc., 35, 56-59.

15. Saxton, J. A. - Basic ground wave propagation characteristics in the frequency band 50-800 Mc/s. Proc. I.E.E., III, 101, 211-214, 1954.

16. Bean, B. R., Meaney, F. M. - Some applications of the monthly median refractivity gradient in tropospheric propagation. Proc. I.R.E., 43, 1419-1431, 1955.

17. Proceedings of I.R.E., Special issue on scattering propagation, 1955.

18. Chisholm, J. H. - Progress of tropospheric propagation research related to communication beyond the horizon. Trans. I.R.E., CS, 6-16, 1956.

19. Bullington, K. - Radio propagation fundamentals. Bell Syst. Techn. J., 36, 593-626, 1957.

20. Rowden, R. A., Stark, J. W. - Long distance propagation at 94.35 Mc/s over the North Sea. Proc. I.E.E., B 104, 210-212, 1957.

21. Dinger, H. E., Garner, W. E., Hamilton, D. H., Teachman, A. E. - Investigation of long distance over-water tropospheric propagation at 400 Mc. Proc. I.R.E., 46, 1401-1410, 1958.

22. Ames, L. A., Martin, E. J., Rogers, T. F. - Some characteristics of persistant VHF radiowave field strengths far beyond the radio horizon. Proc. I.R.E., 47, 769-777, 1959.

23. Stiles, K. P. - Tropospheric scatter path loss test Florida-Bahamas. Trans. I.R.E., CS 7, 205-208, 1959.

24. Millington, G. - The concept of equivalent radius of the earth in tropospheric propagation. Marconi Rev., 20, 79-93, 1957.

25. Booker, H. G., Walkinshaw, W. - The mode theory of tropospheric refraction and its relation to wave guides and diffraction. In Meteorological Factors in Radio Wave Propagation, Phys. Soc., London, 127-168, 1946.

26. Moreland, W. B. - Estimating meteorological effects on radar propagation. Technical Report 183, Volume I, Air Weather Service (MATS), United States Air Force, 1965.

WEATHER

DATA SUMMARIES

FOR SELECTED DAYS

IN SEPTEMBER 1970

WEATHER LOG FOR WEEK OF August 30, 1970

	DAY	SUN	MON	TUES	WED	THURS	FRI	SAT
8:00 AM	Wind Speed and Dir.	22 ENE	16 ENE	8 ENE	8 NE	9 ENE	3 WNW	6 NW
	Sky		CLR	P.C.	P.C.	P.C.	P.C.	
	Precip.		NONE	NONE	NONE	NONE	NONE	
12:00 NOON	Wind Speed and Dir.	22 E	16 NE	10 NE	9 ENE	8 ENE	6 E	6 NW
	Sky		P.C.	P.C.	CLR	P.C.	P.C.	
	Precip.		NONE	NONE	NONE	NONE	NONE	
5:00 PM	Wind Speed and Dir.	21 ENE	10 NE	—	11 ENE	12 E	14 E	11 SE
	Sky		P.C.	CLR	P.C.	P.C.	CLDY	
	Precip.		NONE	NONE	NONE	NONE	NONE	
	Wind Speed and Dir.							
	Sky							
	Precip.							
Past 24 hour Rainfall			.00	.00	.00	.00	.00	

WEATHER LOG FOR WEEK OF September 6, 1970

	DAY	SUN	MON	TUES	WED	THURS	FRI	SAT
8:00 AM	Wind Speed and Dir.	6 WNW	2 WNW	6 WNW	5 N	2 W	4 NW	
	Sky			P.C.	P.C.	P.C.	P.C.	
	Precip.			NONE	NONE	NONE	NONE	
12:00 NOON	Wind Speed and Dir.	8 E	8 NE	14 NE	13 ENE	8 ENE	10 NNE	
	Sky			CLDY	P.C.	CLR	CLDY	
	Precip.			NONE	NONE	NONE	NONE	
5:00 PM	Wind Speed and Dir.	16 E	24 E	12 ENE	15 SSE	23 ENE	14 NNE	
	Sky			P.C.	CLDY	P.C.	P.C.	
	Precip.			NONE	NONE	NONE	NONE	
	Wind Speed and Dir.							
	Sky							
	Precip.							
Past 24 hour Rainfall				.00	.00	.03	.00	

WEATHER LOG FOR WEEK OF SEPTEMBER 13, 1970

	DAY	SUN	MON	TUES	WED	THURS	FRI	SAT
8:00 AM	Wind Speed and Dir.		20 ENE	18 NE	35 ESE	11 ENE	29 ENE	
	Sky		CLDY	CLDY	CLDY	P.C.	CLDY	
	Precip.		LIGHT	NONE	NONE	NONE	NONE	
12:00 NOON	Wind Speed and Dir.		14 E	NONE	26 E	20 ENE	16 ENE	
	Sky		CLDY	CLDY	P.C.	P.C.	CLDY	
	Precip.		NONE	NONE	NONE	NONE	HEAVY	
5:00 PM	Wind Speed and Dir.		3 NNE	8 E	14 ENE	30 ENE	11 SE	
	Sky		OVERCAST	CLDY	P.C.	P.C.	CLDY	
	Precip.		LIGHT	NONE	NONE	NONE	LIGHT	
	Wind Speed and Dir.							
	Sky							
	Precip.							
Past 24 hour Rainfall			.72	.24	.05	.00	.16	

WEATHER LOG FOR WEEK OF SEPTEMBER 20, 1970

	DAY	SUN	MON	TUES	WED	THURS	FRI	SAT
8:00 AM	Wind Speed and Dir.		8 ENE	13 NE	8 SE			
	Sky		CLDY	P.C.	P.C.			
	Precip.		NONE	NONE	MOD.			
12:00 NOON	Wind Speed and Dir.		9 E	13 E	12 ENE			
	Sky		CLDY	P.C.	P.C.			
	Precip.		NONE	NONE	NONE			
5:00 PM	Wind Speed and Dir.		8 E	13 E				
	Sky		CLDY	P.C.				
	Precip.		NONE	NONE				
	Wind Speed and Dir.							
	Sky							
	Precip.							
Past 24 hour Rainfall			.00	.00				

WEATHER OUTLOOK

Rains Bring Flash Flood Threat to Mid-South

SMALL BOAT: Atlantic coastal waters — easterly winds 15 knots with seas 4 to 5 feet, both decreasing. Inland waters choppy but decreasing. Keys southward through Florida Straits — easterly winds 15 knots with seas 4 to 5 feet, briefly higher near showers. Gulf coast — east winds 10 to 15 knots and seas 2 to 3 feet north; easterly winds 15 knots and seas 3 to 4 feet south portion.

MIDDLE WEST COAST AND NAPLES AREAS: Fair through tomorrow with a slight chance of afternoon showers. Afternoon highs in the mid 90s. Lows in the 70s. Easterly winds 10 m.p.h. becoming variable tomorrow. Rain probability 20 per cent.

LAKE OKEECHOBEE AND INDIAN RIVER — BREVARD AREAS: Fair through tomorrow with a slight chance of afternoon showers. Highs in the 90s. Lows in the 70s. Mostly easterly winds 10 m.p.h. Rain probability 20 per cent.

BROWARD — PALM BEACH AND KEYS AREAS: Fair to partly cloudy through tomorrow with a slight chance of afternoon showers. Highs near 90. Lows in the high 70s. Easterly winds 10 to 20 m.p.h. Rain probability 20 per cent, 30 per cent in the Keys.

FLORIDA: Mostly fair except local showers extreme south portion and Keys. Highs 85 to 95; lows near 80 south, 70s elsewhere. Extended outlook through Friday: partly cloudy with a few showers over interior of south and little temperature change.

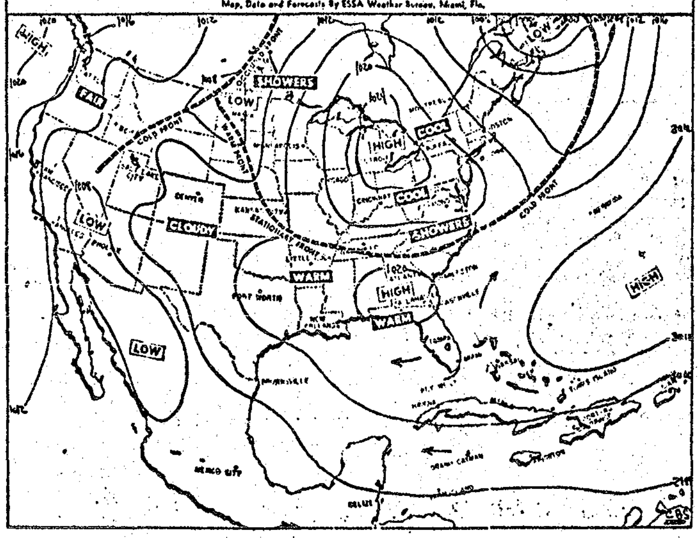
FLORIDA EXTENDED OUTLOOK: Thursday through Saturday; Partly cloudy with a few showers interior sections Thursday and over extreme south portions Friday and Saturday. No important temperature changes. Afternoon highs 88 to 95. Lows mainly in the 70s.

Heavy rains and high winds accompanied a few thunderstorms across the nation. Much of the heaviest rains were concentrated in the middle Mississippi Valley and along the Ohio River. In portions of Missouri and Kentucky flash flooding was predicted because of the rain. The southern Plains also were hit with heavy thunderstorms Fort Worth, Tex., was swamped with more than two inches of rain in one hour. A funnel cloud was observed northeast of Beaumont, Tex. But the windiest conditions during thunderstorms were recorded at scattered cities in the mountains of the West.

Winds of 52 miles an hour ripped through Prescott, Ariz., and a 40-mile-an-hour wind was recorded in Livingston, Mont.

FORECAST WEATHER MAP FOR TUES. A.M. SEPT. 1, 1970

Map, Data and Forecasts By ESSA Weather Bureau, Miami, Fla.



Sunrise Today 7:01 a.m.
Sunset Today 7:40 p.m.

Phases of the Moon

First Qu.	Full	Last Qu.	New
Sept. 8	Sept. 15	Sept. 22	Aug. 31

Moonrise Today 7:33 a.m.
Moonset Today 8:06 p.m.

Local, National, World Temperatures

GREATER MIAMI

	H	L	Precip
Miami Airport	88	81	.66
Miami Beach	86	82	...

FLORIDA

Apalachicola	91	77	...
Clewiston	90	76	...
Daytona Bch.	90	71	...
Ft. Laud.	89	76	...
Ft. Meyers	90	75	...
Gainesville	95	70	...
Homestead	89	74	.07
Islamorada	91	78	...
Jacksonville	90	71	...
Key West	86	76	.31
Lakeland	91	75	...
Naples	94	74	...
Ocala	95	73	...
Pensacola	89	74	...
Tallahassee	94	68	...
Vero Beach	90	78	...
W. P. Bch.	88	81	.12

SOUTH

Asheville	90	60	...
Atlanta	95	71	...
Birmingham	92	68	...
Charleston	96	78	...
Charlotte	95	72	...
J'son, Miss.	92	68	...
Little Rock	92	74	...
Louisville	86	77	...
Memphis	92	72	...
New Orleans	89	74	...
Raleigh	92	71	...
Richmond	95	76	.07

EAST

Albany, N.Y.	73	62	.46
Boston	80	68	.04
Buffalo	68	57	...
New York	79	73	.07
Philadelphia	81	70	.09
Pittsburgh	77	63	.16
Washington	88	76	.02

MIDWEST

Chicago	66	64	...
Cincinnati	85	75	...
Cleveland	69	62	...
Columbus	76	67	.12
Des Moines	82	40	...
Detroit	76	54	...
Duluth	74	33	...
Indianapolis	83	72	...
Kansas City	92	71	...
Milwaukee	68	56	...
Mpls.-St. P.	73	50	...
Omaha	84	57	...
St. Louis	88	72	...

WEST

Albuquerque	87	67	...
Bismarck	86	44	...
Brownsville	95	80	...
Denver	88	53	
Ft. Worth	92	73	2 35
Houston	88	75	...
Las Vegas	104	75	...
Los Angeles	84	64	...
Okla. City	93	69	...
Phoenix	109	82	...
Salt L. City	92	69	...
San Antonio	95	76	...
San Diego	76	64	...
S. Francisco	60	51	...
Seattle	66	60	...

FOREIGN

City	High
Aberdeen	66
Amsterdam	72
Athens	79
Birmingham	64
Cairo	88
Casablanca	77
Copenhagen	72
Dublin	63
Geneva	73
Hong Kong	81
Lisbon	83
Madrid	82
Malta	86
Manila	75
Moscow	73
New Delhi	86
Nice	77
Oslo	61
Paris	75
Rome	77
Saigon	83
Sofia	71
Stockholm	73
Sydney	55
Tel Aviv	86
Tokyo	79
Tunis	86
Vienna	71
Warsaw	72

PAN AMERICAN

Acapulco	88
Barbados	87
Bermuda	85
Bogota	68
Culiacan	99
Havana	88
Hermosillo	106
Kingston	90
Los Mochis	102
Mazatlan	91
Mexico City	72
Monterrey	95
Nassau	84
San Juan P.R.	87
St. Kitts	87
Vera Cruz	81

WEATHER OUTLOOK

SMALL BOATS: Inland waters along the southeast Florida coast including Biscayne and Florida bays — easterly winds 10-15 knots with a light to moderate chop on the waters. Over the Gulf coastal waters — easterly winds 10 knots, moving onshore during the afternoon. Seas 2-3 feet. Over the Atlantic coastal waters from Cape Kennedy to Jupiter Light — variable mostly east winds 10 knots with seas 2-3 feet.

MIDDLE WEST COAST AND BREVARD AREAS — Generally fair through Thursday with a chance of showers. Low 70 to 75. Afternoon highs 90 to 95. Variable winds 10 m.p.h.

NAPLES AND LAKE OKEECHOBEE AREAS — Generally fair through Thursday with a slight chance of afternoon showers. Low in the mid 70s. Afternoon highs 90 to 95. Mostly east winds 10 m.p.h. Rain probability 20 per cent.

BROWARD, PALM BEACH AND KEYS AREAS — Partly cloudy through Thursday with a chance of showers. Low 75 to 80. Afternoon highs 85 to 90. Easterly winds 10 to 15 m.p.h. Rain probability 30 per cent.

FLORIDA — Generally fair, with a few showers in the extreme southern portion and afternoon showers in the extreme northern portion. Highs in the 90s in the north and 89-95 in the south. Night lows 68-75 north and near 80 along the southeast coast and Keys.

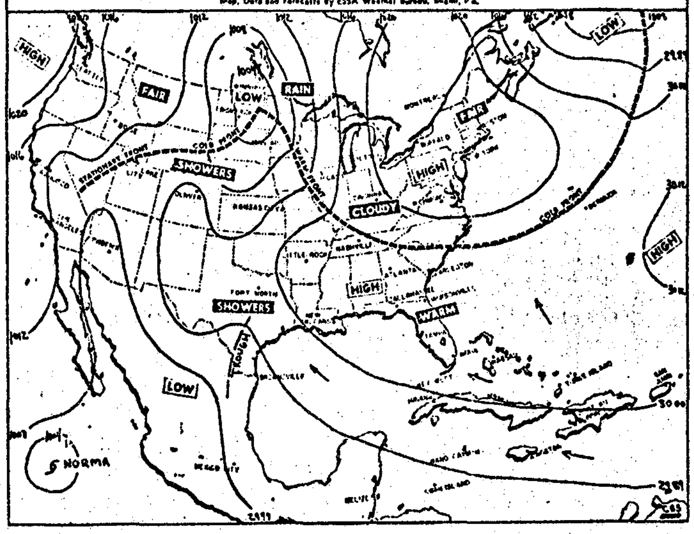
FLORIDA: EXTENDED OUTLOOK — Friday through Sunday: Partly cloudy with widely scattered mainly afternoon and evening thundershowers. Afternoon highs 88 to 95. Overnight lows mainly in the 70s.

Some Cooling Expected Over Much of Nation

Scattered thundershowers rumbled this afternoon in all but the Pacific Coast states and in the northeastern quarter of the nation and some of these storms were severe. Temperatures were high over much of the United States, particularly in the northern Plains region and the Southwest. Cooler temperatures prevailed in the Northeast. The national weather forecast: Cool weather will continue in the northeastern states and in the Pacific Northwest, and cooler air is likely from the northern Plains to the southern plateau region. Fair skies will be the rule, but some thundershowers will be scattered from the Appalachians to the Rockies.

FORECAST WEATHER MAP FOR WED. A.M. SEPT. 2, 1970

Map, Data and Forecasts By ESSA Weather Bureau, Miami, Fla.



Sunset Today 7:39 p.m.

Sunset Today 7:40 p.m.

Phases of the Moon

First Qu. Full Last Qu. New

Sept. 8 Sept. 15 Sept. 22 Aug. 31

Moonrise Today 8:23 a.m.

Moonset Today 8:33 p.m.

Local, National, World Temperatures

GREATER MIAMI

	H	L	Precip
Coral Gables	87	77	19
Miami Airport	87	80	27
Miami Beach	86	77	11
North Miami Beach	93	79	...
South Miami	90	74	.13

FLORIDA

Apalachicola	90	73	.
Clewiston	90	74	...
Clewiston	90	74	...
Daytona Bch	94	70	...
Ft. Laud.	90	76	...
Ft. Myers	91	74	...
Gainesville	95	70	...
Homestead	90	73	.04
Islamorad	91	78	...
Jacksonville	95	75	.19
Key West	87	77	...
Lakeland	91	72	...
Naples	95	74	...
Ocala	97	70	...
Orlando	95	70	...
Pensacola	91	75	...
Sarasota	94	71	...
St. Pete.	93	78	...
Tallahassee	95	63	...
Tampa	94	69	...
Vero Beach	91	72	.
W.P. Bch	88	81	.04

SOUTH

Asheville	87	66	...
Atlanta	93	73	.
Birmingham	91	78	...
Charleston	93	78	
Charlotte	90	75	...
Little Rock	97	71	.
New Orleans	87	72	10
Raleigh	84	67	...
Richmond	84	63	...

EAST

Albany, N.Y.	70	50	...
Boston	72	55	...
Buffalo	70	51	...
New York	75	57	...
Philadelphia	74	59	...
Pittsburgh	72	47	...
Washington	70	64	...

MIDWEST

Chicago	70	43	...
Cincinnati	83	65	...
Cleveland	70	42	...
Columbus	74	53	...
Des Moines	89	67	.
Detroit	74	43	.
Duluth	75	44	.02
Indianapolis	92	69	...
Kansas City	95	75	...
Milwaukee	71	44	...
Mpls.-St. P.	78	56	...
Omaha	94	66	...
St. Louis	88	69	...

WEST

Bismarck	94	55	...
Brownsville	93	77	...
Denver	90	54	.04
Ft. Worth	82	72	1.58
Houston	76	72	2.02
Las Vegas	101	76	...
Los Angeles	84	64	...
Okla. City	87	72	...
Phoenix	109	81	...
Salt L. City	89	63	...
San Antonio	84	75	...
San Diego	75	65	...
S. Francisco	61	52	...
Seattle	67	58	...

FOREIGN

City	High
Aberdeen	61
Auckland	57
Berlin	71
Birmingham	61
Casablanca	79
Copenhagen	68
Dublin	63
Geneva	72
Hong Kong	84
Lisbon	81
London	61
Madrid	86
Manila	73
Moscow	66
New Delhi	91
Nice	77
Oslo	63
Paris	64
Rome	79
Saigon	82
Sofia	61
Stockholm	71
Tel Aviv	86
Tokyo	82
Warsaw	73

PAN AMERICAN

Acapulco	82
Havana	88
Hermosillo	85
Kingston	90
Los Mochis	85
Mazatlan	91
Mexico City	73
Monterrey	84
Nassau	8
St Kitts	88
Vera Cruz	89

WEATHER OUTLOOK

SMALL BOATS: Over the Atlantic coastal waters from Jupiter Light to Key Largo and eastward thru the western Bahamas — easterly winds 10 to occasionally 15 knots with seas 2-3 feet. Inland waters along the southeastern Florida coast including Biscayne and Florida bays — easterly winds 10 to occasionally 15 knots during the afternoon. Waters will have only a light chop. Over the gulf coastal waters north of Florida Bay to Cedar Key — variable winds 10 knots becoming onshore during the afternoon. Seas 2 feet.

MIDDLE WEST COAST AND NAPLES AREAS: Generally fair through tomorrow but with chance of an afternoon thundershower. Low tonight in the 70s. Afternoon highs 90 to 96. Variable winds 10 m.p.h. gusty mear thundershowers. Rain probability 30 per cent.

LAKE OKEECHOBEE AND INDIAN RIVER-BREVARD AREAS: Generally fair through tomorrow with only a slight chance of showers. Low tonight 72 to 76. Afternoon highs in the low 90s. Variable winds 10 m.p.h. becoming easterly in the afternoon. Rain probability 20 per cent.

BROWARD-PALM BEACH AND KEYS AREAS: Partly cloudy through tomorrow with only a chance of a shower. Low tonight 75 to 80. Afternoon highs near 90. Easterly winds 10 to occasionally 15 m.p.h. Rain probability 30 per cent.

FLORIDA: Generally fair, with a chance of afternoon thundershowers. Highs 90-96. Lows at night mainly in the 70s, near 80 in the southern part of the state.

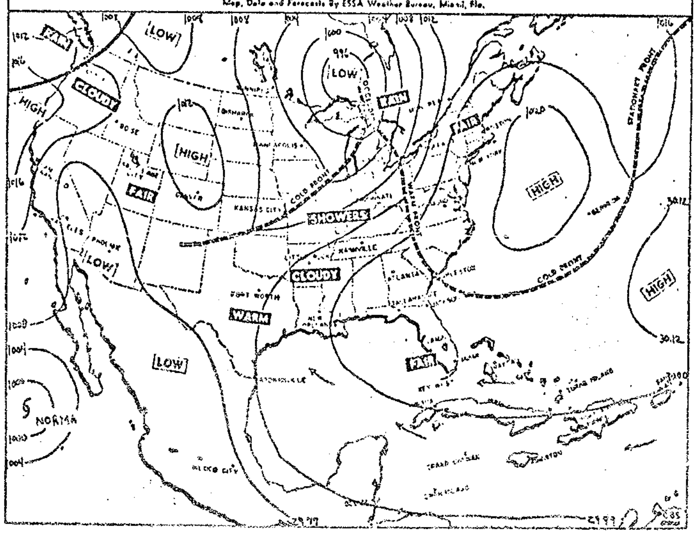
FLORIDA EXTENDED OUTLOOK: Saturday through Monday: Partly cloudy with widely scattered mainly afternoon and evening thundershowers. Afternoon highs 88 to 95. Overnight lows mainly in the 90s.

Rains Causing Flooding in Texas, Oklahoma

Locally heavy rain in eastern Texas and southeastern Oklahoma caused many rivers and streams to overflow. Three to seven inches of rain fell in the last 24-36 hours in many parts of the region. Scattered showers and locally heavy thundershowers also occurred from Minnesota and eastern South Dakota to Louisiana, and in the northern Great Lakes and the Southeast. The weather remained sunny, warm and dry from the high Plains to the interior sections of the Pacific states. A large cool air system also brought and pleasant conditions to the Northeast. The national forecast: Sunny weather is in store for much of the nation. Scattered mainly afternoon thundershowers are expected from the Gulf to Michigan.

FORECAST WEATHER MAP FOR THURS. A.M. SEPT. 3 , 1970

Map, Data and Forecasts By ESSA Weather Bureau, Miami, Fla.



Sunrise Today 7:02 a.m. Phases of the Moon Moonrise Today 9:15 a.m.

Sunset Today 7:38 p.m. Moonset Today 9:03 p.m.

First Qu. Full Last Qu. New

Sept. 8 Sept. 15 Sept. 22 Sept. 30

Local, National, World

Temperatures

GREATER MIAMI

	H	L	Precip
Coral Gables	87	77	19
Miami Airport	87	80	27
Miami Beach	86	77	.11
North Miami Beach	93	79	...
South Miami	90	76	.13

FLORIDA

Apalachicola	90	73	.
Clewiston	90	74	...
Clewiston	90	74	...
Daytona Bch	94	70	...
Ft. Laud.	90	76	...
Ft. Myers	91	74	...
Gainesville	95	70	...
Homestead	90	73	.04
Islamorad	91	78	...
Jacksonville	95	75	.39
Key West	87	77	...
Lakeland	91	72	...
Naples	95	74	...
Ocala	97	70	...
Orlando	95	70	...
Pensacola	91	75	...
Sarasota	94	71	...
St. Pete.	93	78	. .
Tallahassee	95	63	...
Tampa	94	69	...
Vero Beach	91	72	
W.P. Bch	88	81	04

SOUTH

Asheville	87	66	...
Atlanta	93	73	
Birmingham	91	70	...
Charleston	93	78	
Charlotte	90	75	.
Little Rock	97	71	.
New Orleans	87	77	.10
Raleigh	84	67	...
Richmond	84	63	...

EAST

Albany, N.Y.	70	50	...
Boston	72	55	...
Buffalo	70	51	...
New York	75	57	...
Philadelphia	74	59	...
Pittsburgh	72	47	...
Washington	79	64	...

MIDWEST

Chicago	70	63	...
Cincinnati	83	65	...
Cleveland	70	42	...
Columbus	74	53	...
Des Moines	89	67	.
Detroit	76	43	...
Duluth	75	44	.03
Indianapolis	92	69	...
Kansas City	95	75	...
Milwaukee	71	46	...
Mpls.-St. P.	78	56	...
Omaha	94	66	...
St. Louis	86	69	...

WEST

Albuquerque	87	60	
Anchorage	63	49	
Bismarck	86	55	
Brownsville	95	77	
Denver	88	54	
Ft. Worth	92	72	3 74
Houston	88	76	15
Las Vegas	105	79	
Los Angeles	84	64	
Okla. City	95	72	
Phoenix	107	85	
Salt L. City	72	64	17
San Antonio	93	75	
San Diego	78	62	
S. Francisco	61	53	
Seattle	66	58	

FOREIGN

City	High
Aberdeen	61
Auckland	57
Berlin	71
Birmingham	61
Casablanca	79
Copenhagen	68
Dublin	61
Geneva	73
Hong Kong	84
Lisbon	81
London	61
Madrid	86
Manila	73
Moscow	66
New Delhi	91
Nice	77
Oslo	63
Paris	64
Rome	79
Saigon	82
Sofia	61
Stockholm	71
Tel Aviv	86
Tokyo	82
Warsaw	73

PAN AMERICAN

Acapulco	82
Havana	82
Hermosillo	85
Kingston	90
Los Mochis	85
Mazatlan	91
Mexico City	72
Monterrey	84
Nassau	8
St Kitts	86
Vera Cruz	89

WEATHER OUTLOOK

A Fine Labor Day Weekend Awaits Mid-America

SMALL BOATS: Over the Atlantic coastal waters from Jupiter Light to Key Largo and eastward through the western Bahamas — east and southeast winds 10 to occasionally 15 knots with seas 2 to 3 feet. Over inland waters along the southeast Florida coast including Biscayne and Florida bays — east and southeast winds 10 to occasionally 15 knots with a light to moderate chop on the waters. Over the Atlantic coastal waters from Cape Kennedy to Jupiter Light — variable winds to 10 knots becoming east and southeast 10 to 15 knots during the afternoon, seas 2 to 3 feet.

MIDDLE WEST COAST AREAS: Partly cloudy through Sunday with chance of afternoon thundershowers. Low tonight in 70s. Afternoon high in low to mid 90s. Variable winds 10 to occasionally 15 mph gusty near thundershowers. Rain probability 30 per cent.

NAPLES — LAKE OKEECHOBEE AREAS: Partly cloudy through Sunday with chance of afternoon and evening thundershowers. Low tonight in 70s. Afternoon highs 90 to 95. Variable winds 10 to occasionally 15 mph becoming southwesterly in afternoons. Winds gusty near thundershowers. Rain probability 50 per cent.

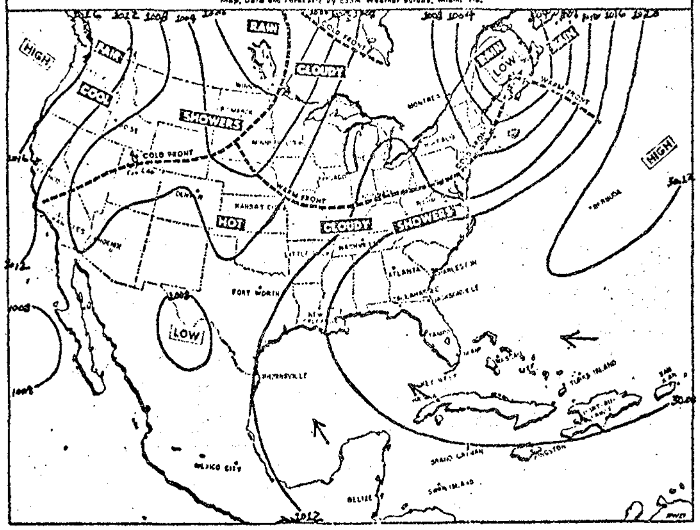
INDIAN RIVER—BROWARD—KEYS AREAS: Partly cloudy through Sunday with chance of a few showers. Low tonight 75 to 80. Afternoon highs near 90. East and southeast winds 10 to 15 mph gusty near showers. Rain probability 30 per cent.

FLORIDA — EXTENDED OUTLOOK: Monday through Wednesday. Widely scattered mainly afternoon thundershowers. Partly cloudy weather. Daytime highs 88 to 96. Over-night lows mainly in 70s.

Mostly fair weather heralds the beginning of the Labor Day weekend over the nation's midsection and in the Southwest. Fine weather is typical from the eastern slopes of the Rockies to the upper and lower Mississippi Valley and in the Middle Atlantic states. Showers are prevalent over the Southeast and in New England. The national weather forecast: A sunny and pleasant day is expected over much of the nation. However, it will turn cooler over the central Rockies and parts of the Great Basin. Widely scattered thundershowers will occur from the lower Mississippi Valley into the Carolinas and Florida.

FORECAST WEATHER MAP FOR SAT. A.M. SEPT. 5, 1970

Map, Data and Forecasts by ESSA Weather Bureau, Miami Fla.



Sunrise Today 7:02 a.m.

Sunset Today 7:36 p.m.

Phases of the Moon

First Qu.	Full	Last Qu.	New
Sept. 8	Sept. 15	Sept. 22	Sept. 30

Moonrise Today 11:04 a.m.

Moonset Today 10:07 p.m.

Local, National, World Temperatures

GREATER MIAMI

	H	L	Precip.
Coral Gables	90	80	...
Miami Airport	89	79	...
Miami Beach	88	82	...
North Miami Beach	94	77	...
South Miami	93	78	...

FLORIDA

	H	L	Precip.
Apalachicola	90	70	...
Clewiston	91	71	...
Daytona Bch.	93	76	...
Ft. Laud.	91	84	...
Ft. Myers	91	75	..
Gainesville	93	74	.13
Islamorada	91	82	.62
Jacksonville	96	76	...
Key West	88	80	...
Lakeland	91	75	..
Naples	91	73	.31
Ocala	97	73	...
Orlando	96	76	92
Pensacola	90	76	.92
St. Pete.	90	80	..
Tallahassee	94	67	62
Tampa	91	77	20
Vero Beach	92	73	..
W. P. Bch.	90	78	...

SOUTH

	H	L	Precip.
Asheville	89	62	.09
Atlanta	88	72	
Birmingham	89	75	19
Charleston	91	80	.04
Charlotte	91	73	..
J'son, Miss.	92	74	:
Little Rock	89	68	48
Louisville	80	71	03
Memphis	87	69	1 09
New Orleans	93	74	..
Raleigh	89	69	.23
Richmond	95	72	.14

EAST

	H	L	Precip.
Albany, N.Y.	84	67	.04
Boston	84	65	.
Buffalo	75	70	.24
New York	90	73	.04
Philadelphia	91	76	...
Pittsburgh	85	69	.43
Washington	94	77	...

MIDWEST

	H	L	Precip.
Chicago	80	69	...
Cincinnati	84	71	03
Cleveland	85	67	.22
Columbus	84	69	.88
Des Moines	87	67	.
Detroit	86	68	.03
Duluth	85	55	..
Indianapolis	77	68	.01
Kansas City	87	68	1 84
Milwaukee	82	64	...
Mpls.-St. P.	87	57	...
Omaha	84	63	...
St. Louis	87	71	...

WEST

	H	L	Precip.
Albuquerque	71	62	03
Bismarck	95	61	..
Brownsville	96	80	...
Denver	86	53	...
Ft. Worth	95	77	...
Houston	92	79	...
Las Vegas	96	74	...
Los Angeles	77	58	...
Okla. City	101	79	.
Phoenix	84	74	30
Salt L. City	86	63	...
San Antonio	99	79	...
San Diego	72	64	...
S. Francisco	64	54	..
Seattle	65	53	.16

FOREIGN

City	High
Aberdeen	54
Amsterdam	63
Athens	82
Berlin	61
Birmingham	60
Brussels	63
Casablanca	79
Copenhagen	61
Dublin	61
Geneva	72
Hong Kong	81
Lisbon	86
London	66
Madrid	86
Malta	83
Manila	77
Moscow	64
New Delhi	79
Oslo	59
Paris	64
Rome	81
Saigon	82
Sofia	75
Stockholm	63
Sydney	61
Tel Aviv	84
Tokyo	73
Tunis	86
Vienna	61
Warsaw	57

PAN AMERICAN

Acapulco	82
Barbados	88
Bermuda	81
Bogota	66
Culiacan	82
Havana	88
Kingston	88
Mexico City	77
San Juan P.R.	88
St. Kitts	87
Vera Cruz	88

WEATHER OUTLOOK

MIDDLE WEST COAST AND NAPLES AREAS: Partly cloudy through tomorrow with a chance of afternoon thundershowers. Lows in the 70s. Highs 90 to 94. Variable winds 10 m.p.h. gusty near showers. Rain probability 40 per cent.

LAKE OKEECHOBEE AND INDIAN RIVER-BREVARD AREAS: Partly cloudy through tomorrow with a chance of afternoon thundershowers. Lows in the 70s. Highs 90 to 96. Variable winds 10 m.p.h. gusty near showers. Rain probability 30 per cent.

BROWARD-PALM BEACH AND KEYS AREAS: Partly cloudy through tomorrow with a chance of showers. Lows in the high 70s. Highs around 90. Mostly easterly winds 10 m.p.h. Rain probability 30 per cent.

FLORIDA: Partly cloudy with widely scattered mainly afternoon and evening thundershowers except a few night and morning showers Keys and southeastern beaches. Afternoon highs 81 to 96.

FLORIDA EXTENDED OUTLOOK: Wednesday through Friday: Warm with widely scattered afternoon thundershowers. Highs 88 to 96. Lows in 70s.

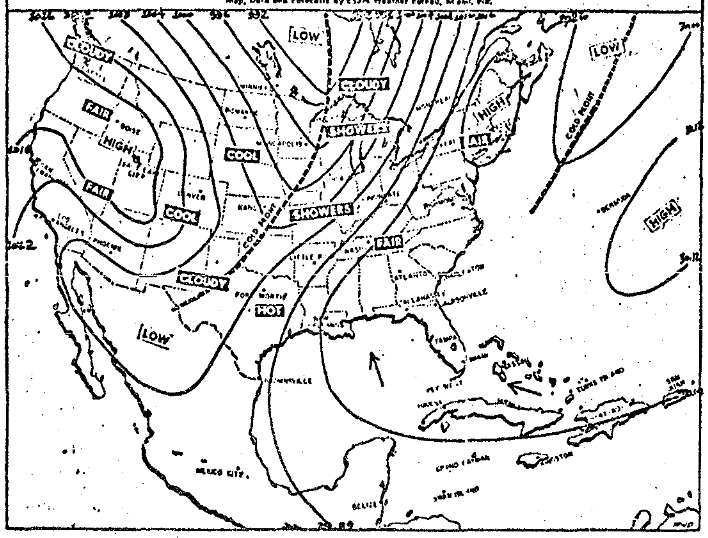
SMALL BOATS: Atlantic coastal waters — Variable winds 10 knots becoming easterly during the afternoons. Seas 2 feet or less. Inland waters will have a light chop except briefly choppy near a few thundershowers. Keys southward through the Florida straits — East and southeast winds 10 knots with seas around 2 feet. Winds and seas briefly higher near a few thundershowers. Gulf coastal waters — Variable winds 10 knots becoming onshore during the afternoons. Seas 2 feet or less. Winds and seas briefly higher near a few thundershowers.

Rains Dot West; East, South Continue Warm

The holiday weather was one of contrast across the nation. Travelers warnings remained in effect for the Colorado Rockies because of snow in the higher mountain elevations and passes. At the same time locally heavy rains spread across Arizona and New Mexico while warm weather continued in a broad sweep from the Gulf states northward to the Canadian border. Rain or shower activity was scattered from the Northwest to the Great Basin. Thundershowers occurred along the humid Gulf regions and in advance of a cold front headed toward the upper Mississippi Valley. The national forecast: occasional showers are expected from the Pacific Northwest to the north and central Rockies with snow in the mountains of the central Rockies.

FORECAST WEATHER MAP FOR MON. A.M. SEPT. 7, 1970

Map, Data and Forecasts By ESSA Weather Bureau, Miami, Fla.



Sunrise Today 7:03 a.m.
Sunset Today :34 p.m.

Phases of the Moon

Sept. 8 Sept. 15 Sept. 22 Sept. 30

Moonrise Today 1:02 p.m.
Moonset Today 11:34 p.m.

Local, National, World Temperatures

GREATER MIAMI

	H	L	Precip		H	L	Precip.
Coral Gables	89	75	....	North Miami Beach	95	75	....
Miami Airport	90	77	....	South Miami	93	72	....
Miami Beach	88	80	....				

FLORIDA

Apalachicola	94	79	...
Clewiston	91	71	.
Daytona Bch.	91	74	.16
Ft. Laud.	91	82	...
Ft. Myers		74	...
Gainesville	93	74	...
Islamorada	91	82	...
Jacksonville	94	74	...
Key West	88	79	...
Lakeland	93	76	...
Naples	91	72	.
Orlando	94	76	.08
Pensacola	92	76	...
St. Pete.	93	78	...
Tallahassee	92	70	..
Tampa	90	74	.40
Vero Beach	93	74	..
W.P. Bch.	90	74	.01

SOUTH

Asheville	86	66	...
Atlanta	88	71	..
Birmingham	87	73	.03
Charleston	90	78	...
Charlotte	92	71	...
J'son, Miss.	94	74	...
Little Rock	92	75	...
Louisville	84	67	...
Memphis	91	79	...
New Orleans	92	76	...
Raleigh	85	67	...
Richmond	93	70	...

EAST

Boston	84	66	...
Buffalo	69	64	...
New York	90	73	...
Philadelphia	87	73	...
Pittsburgh	80	63	.51
Washington	91	73	...

MIDWEST

Chicago	81	67	.
Cincinnati	85	65	.15
Cleveland	76	62	.09
Columbus	83	60	..
Des Moines	73	63	.27
Detroit	83	58	...
Duluth	72	59	.
Indianapolis	85	57	.12
Kansas City	90	75	.05
Milwaukee	78	60	...
Mpls-St. P.	88	65	.
Omaha	81	67	.03
St. Louis	80	60	.03

WEST

Albuquerque	86	60	...
Bismarck	96	48	...
Brownsville	96	79	...
Denver	80	55	...
Houston	91	78	...
Las Vegas	80	68	...
Los Angeles	78	63	...
Okla. City	99	76	.
Phoenix	83	72	1.46
Salt L. City	55	47	1.61
San Antonio	98	77	..
San Diego	69	64	...
S. Francisco	72	58	..
Seattle	59	53	...

FOREIGN

City	High
Aberdeen	59
Amsterdam	63
Ankara	77
Athens	84
Auckland	54
Berlin	64
Birmingham	63
Brussels	70
Cairo	43
Casablanca	89
Copenhagen	61
Dublin	61
Geneva	73
Hong Kong	82
Lisbon	91
London	70
Madrid	89
Malta	84
Moscow	63
New Delhi	81
Nice	77
Oslo	63
Paris	70
Rome	81
Saigon	82
Sofia	70
Stockholm	57
Sydney	57
Tel Aviv	84
Tokyo	79
Tunis	84
Vienna	70
Warsaw	57

PAN AMERICA

Acapulco	88
Barbados	82
Bermuda	80
Culiacan	90
Havana	91
Hermosillo	84
Kingston	90
Los Mochis	91
Mexico City	75
Monterrey	99
Nassau	81
SanJuan PR	88
St Kitts	87
Vera Cruz	90

WEATHER OUTLOOK

East and West Get Their First Taste of Autumn

MIAMI AND VICINITY: Sunny today with high near 90. Low in the 70s. Mostly east winds 10 m.p.h. Shower probability 30 per cent.

SMALL BOATS: Inland waters along the southeast Florida coast, including Biscayne and Florida bays — variable mostly east and southeast winds 10 knots with light chop on waters. Gusty winds and choppy waters near widely scattered thundershowers.

FLORIDA: Partly cloudy with widely scattered thundershowers mainly over the southern two thirds of the state in afternoons, persisting over adjacent waters at night. Highs 88 to 95. Lows in the 70s.

FLORIDA EXTENDED OUTLOOK: Thursday through Saturday. Warm throughout state with widely scattered afternoon thundershowers. Highs 88 to 96. Lows in the 70s.

KEYS AREAS: Partly cloudy through tomorrow with chance of showers. Lows upper 70s. Highs near 90. Variable mostly southeast winds 10 m.p.h. Rain probability 30 per cent.

MIDDLE WEST COAST, NAPLES AND LAKE OKEECHOBEE AREAS: Partly cloudy through tomorrow with chance of afternoon thundershowers. Lows 70 to 76. Highs 88 to 94. Variable winds 10 m.p.h. gusty near showers. Rain probability 40 per cent.

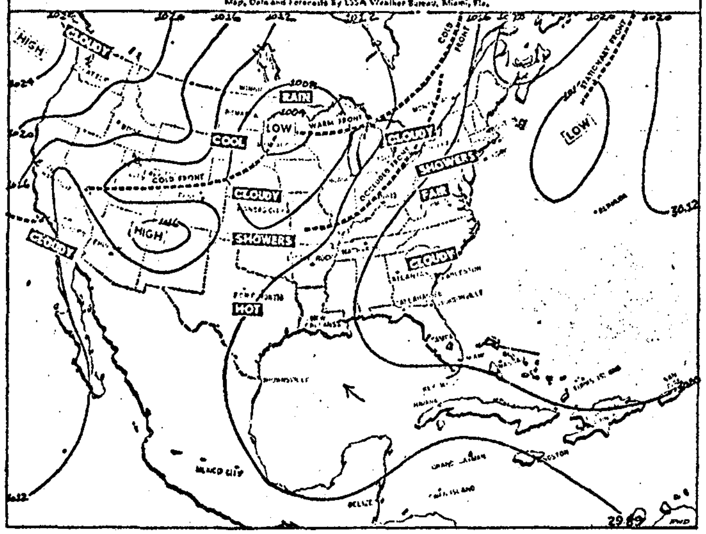
Statistics

September 8, 1970	7:00 A.M.	7:00 P.M.
Barometer (inches)	29.95	29.94
Relative humidity	91%	80%
Highest temperature (last 12 hours)		90
Lowest temperature (last 18 hours)		76
Mean temperature		83
Normal temperature		82
Accumulated excess since first of month		15
Accumulated excess in temperature since Jan. 1 (degrees)		177
Highest and lowest this date since 1939		93 and 71
Local rainfall for 24 hours ending 7 p.m.		0
Rainfall this month in inches		.27
Rainfall deficiency this month in inches		1.93
Rainfall since Jan. 1 in inches		32.83
Deficiency since Jan. 1 in inches		6.95

Autumn-like weather showed up on the weather scene in the Northwest and Northeast. High pressure dominated and cool air held sway in these areas as high temperatures reached only to the 60s. Meanwhile, fair and pleasant weather was the rule from the Southwest to the upper and middle Mississippi Valley. Scattered showers and thunderstorms occurred over the Gulf states and the lower Plains and lines of thunderstorms were active along a cold front from New York to eastern Kentucky. The national weather forecast for today: Sunny and pleasant weather is in store for most of the nation. Scattered showers and thunderstorms are on tap from the Gulf states to the Ohio Valley

FORECAST WEATHER MAP FOR WED. A.M. SEPT. 9, 1970

Map, Data and Forecasts By ESSA Weather Bureau, Miami, Fla.



Sunrise Today 7:01 a.m.
Sunset Today 7:32 p.m.

Phases of the Moon

Sept. 8 Sept. 15 Sept. 22 Sept. 30

Moonrise Today 3:04 p.m.
Moonset Thurs. 1:28 a.m.

Local, National, World Temperatures

GREATER MIAMI

	H	L	Precip		H	L	Precip.
Coral Gables	92	74	...	North Miami Beach	96	72	...
Miami Airport	90	76	...	South Miami	96	69	...
Miami Beach	88	79	...				

FLORIDA

Apalachicola	91	75	...
Bradenton	90	72	.22
Clewiston	91	69	...
Daytona Bch.	91	73	...
Ft. Laud.	90	74	...
Ft. Myers	92	75	.10
Gainesville	91	71	...
Homestead	92	69	...
Islamorada	93	78	...
Jacksonville	91	72	...
Key West	88	78	...
Lakeland	91	69	1.30
Naples	91		...
Ocala	94	70	1.28
Orlando	95	74	...
Pensacola	90	74	1.41
Sarasota	90	72	.22
St. Pete.	95	78	...
Tallahassee	91	70	...
Tampa	91	72	...
Vero Beach	93	74	...
W.P. Bch.	92	76	...

SOUTH

Asheville	77	59	...
Atlanta	84	71	...
Birmingham	87	67	.15
Charleston	86	74	...
Charlotte	79	65	...
J'son, Miss.	95	72	...
Little Rock	96	72	...
Louisville	85	71	...
Memphis	94	74	...
New Orleans	92	75	...
Raleigh	83	59	...
Richmond	87	57	...

EAST

Albany, N.Y.	73	57	...
Bermuda	82	73	.18
Boston	64	54	...
Buffalo	79	59	...
Montreal	68	41	...
New York	79	61	...
Philadelphia	83	63	...
Pittsburgh	81	59	...
Toronto	71	56	...
Washington	85	60	...

MIDWEST

Chicago	89	67	.04
Cincinnati	86	72	.10
Cleveland	84	65	...
Columbus	86	65	...
Des Moines	87	55	...
Detroit	85	70	...
Duluth	85	47	...
Indianapolis	89	72	...
Kansas City	87	45	...
Milwaukee	88	62	...
Mpls.-St. P.	84	53	...
Omaha	81	40	...
St. Louis	96	66	1.09

WEST

Albuquerque	84	56	...
Anchorage	54	36	...
Bismarck	74	55	.12
Brownsville	96	78	...
Denver	83	44	...
Ft. Worth	94	75	...
Houston	93	78	...
Las Vegas	92	67	...
Los Angeles	83	65	...
Okla. City	100	73	.04
Phoenix	93	77	...
Salt L. City	76	60	...
San Antonio	98	77	...
San Diego	78	63	...

FOREIGN

City	High
Aberdeen	57
Amsterdam	66
Ankara	75
Athens	84
Auckland	57
Berlin	63
Birmingham	52
Brussels	72
Cairo	86
Dublin	63
Geneva	70
Hong Kong	86
Lisbon	73
London	70
Madrid	88
Malta	82
Moscow	57
New Delhi	86
Nice	77
Paris	75
Rome	79
Saigon	84
Sydney	59
Tel Aviv	86
Tokyo	75
Vienna	66

PAN AMERICAN

Acapulco	95
Barbados	87
Bogota	44
Havana	88
Hermosillo	86
Kingston	88
Los Mochis	91
Mexico City	81
Monterrey	95
Nassau	90
San Juan, PR	88
St. Kitts	87
Vera Cruz	91

WEATHER OUTLOOK

SMALL BOATS: Atlantic coastal waters — east and southeast winds 10-15 knots with seas 2-3 feet. Inland waters along the Southeast Florida coast including Biscayne and Florida bays—east and southeast winds 10-15 knots with a light to moderate chop on waters, except choppy near showers. Keys southward through the Florida Straits — southeast winds 15-20 knots with seas 3-5 feet. Gulf coastal waters — variable winds 10-15 knots with seas 2-4 feet.

MIDDLE WEST COAST AND NAPLES AREAS: Partly cloudy through tomorrow with a chance of afternoon and evening thundershowers. Lows in the 70s. Highs 83 to 94. Mostly east and southeast winds 10 to 15 m.p.h. gusty near showers. Rain probability 50 per cent.

LAKE OKEECHOBEE AND INDIAN RIVER BREVARD AREAS: Partly cloudy through tomorrow with a chance of afternoon and evening thundershowers. Lows in the 70s. Highs 88 to 94. Mostly east and southeast winds 10 to 15 m.p.h. gusty near showers. Rain probability 50 per cent.

BROWARD-PALM BEACH AND KEYS AREAS: Mostly cloudy through tomorrow with showers likely. Lows in the upper 70s. Highs 85 to 9[illegible] East and southwest winds 15 to occasionally 20 m.p.h. gusty near showers. Rain probability 60 per cent.

FLORIDA: Partly cloudy with scattered showers likely throughout the state. High 86-94.

FLORIDA EXTENDED OUTLOOK: Saturday through Monday: Warm with scattered mainly afternoon thundershowers. Lows in 70s. Highs around 90.

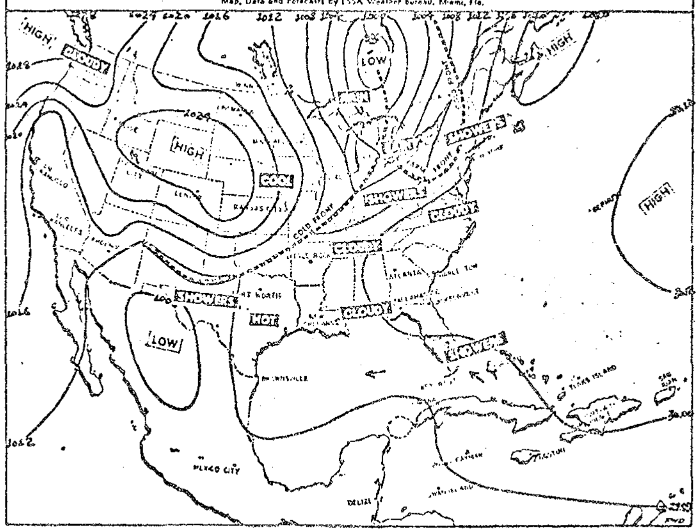
Cold Front Cools Off Great Plains States

On the heels of a cold front, sharply cooler air has invaded much of the Great Plains. Temperatures mostly in the 50s replaced readings in the 90s in much of South Dakota and Nebraska. Ahead of the front in the Midwest and southern Plains, warmer and more humid conditions were the rule with readings in the 80s and 90s. Precipitation was mostly light across the nation with amounts under a quarter of an inch. The national weather forecast:

Showers and thundershowers will be scattered from the Mississippi River eastward and in the southern Plains. Fair and dry weather will prevail elsewhere. Warming is on tap from the intermountain region of the West to the Pacific Coast and in the Atlantic Coast states.

FORECAST WEATHER MAP FOR THURS. A.M. SEPT 10, 1970

Map, Data and Forecasts By ESSA Weather Bureau, Miami, Fla.



Sunrise Today 7:04 a.m. Sunset Today 7:31 p.m.

Phases of the Moon: First Qu. Oct. 7 · Full Sept. 15 · Last Qu. Sept. 22 · New Sept. 30

Moonrise Today 4:01 p.m. Moonset Fri. 2:35 a.m.

Local, National, World Temperatures

GREATER MIAMI

	H	L	Precip
Coral Gables	89	73	.03
Miami Airport	89	79	...
Miami Beach	86	79	...
North Miami Beach	93	74	
South Miami	90	71	.19

FLORIDA

	H	L	Precip
Apalachicola	88	76	...
Bradenton	93	73	...
Clewiston	91	71	...
Daytona Bch.	90	75	...
Ft. Laud.	90	74	...
Ft. Myers	92	74	.13
Gainesville	90	73	...
Homestead	90	70	.01
Islamorada	87	76	...
Jacksonville	89	73	...
Key West	85	77	.22
Lakeland	91	74	...
Naples	93	72	.06
Ocala		74	...
Orlando	93	76	...
Sarasota	93	73	..
St. Pete	92	78	.01
Tallahassee	90	72	.25
Tampa	91	73	.44
Vero Beach	92	73	.
W.P. Bch		74	.20

SOUTH

	H	L	Precip
Asheville	84	62	.22
Atlanta	55	67	...
Birmingham	88	69	...
Charleston	84	70	...
Charlotte	85	68	...
J'son, Miss.	93	71	...
Little Rock	97	72	...
Louisville	87	69	...
Memphis	93	75	...
New Orleans	89	72	.33
Raleigh	82	63	...
Richmond	87	65	...

EAST

	H	L	Precip
Albany, N.Y.	67	53	.09
Boston	64	54	.03
Buffalo	79	66	.17
New York	70	64	.09
Philadelphia	72	66	.32
Pittsburgh	82	67	.14
Washington	70	66	...

MIDWEST

	H	L	Precip
Chicago	90	61	...
Cincinnati	86	65	...
Cleveland	81	62	...
Columbus	82	62	.
Des Moines	89	62	1.92
Detroit	81	63	...
Indianapolis	84	58	...
Kansas City	99	71	.68
Milwaukee	75	50	...
Mpls.-St. P.	72	64	.11
Omaha	83	62	.10
St. Louis	90	61	.14

WEST

	H	L	Precip
Albuquerque	92	58	.
Bismarck	60	50	.62
Brownsville	97	73	...
Denver	74	54	...
Fort Worth	[illegible]	[illegible]	...
Houston	94	78	...
Las Vegas	100	68	...
Los Angeles	85	64	...
Okla. City	99	70	...
Phoenix	101	76	...
Salt L. City	68	45	...
San Antonio	97	76	...
San Diego	74	65	...
S. Francisco	73	55	...
Seattle	66	47	...

FOREIGN

Aberdeen	55
Amsterdam	64
Ankara	72
Athens	86
Auckland	55
Berlin	72
Birmingham	55
Brussels	63
Casablanca	75
Copenhagen	63
Dublin	55
Geneva	77
Hong Kong	75
Lisbon	73
Madrid	77
Malta	82
Moscow	50
Paris	70
Rome	82
Saigon	81
Sydney	52
Tokyo	82
Tunis	88
Vienna	79
Warsaw	73

PAN AMERICAN

Acapulco	88
Barbados	86
Bermuda	83
Culiacan	93
Havana	88
Hermosillo	97
Kingston	88
Mazatlan	84
Mexico City	73
Monterrey	97
Nassau	88
San Juan P.R.	86
St. Kitts	87
Vera Cruz	86

Dixie Remains Warm as the North Cools Off

WEATHER OUTLOOK

M[illegible]MI AND VICINITY: A few showers likely today becoming sunny Wednesday. High in the upper-80s. Low tonight upper-70s. Easterly winds 10-15 m.p.h. Shower probability 60 per cent today.

SMALL BOATS: Atlantic coastal waters — easterly winds 15 knots with seas 2-4 [illegible]. Winds and seas higher near scattered showers. Inland waters [illegible] Florida coast including Biscayne and Florida [illegible] winds [illegible] knots with a [illegible] chance [illegible] waters [illegible] showers.

FLORIDA: Considerable cloudiness with chance of afternoon showers, less likely in north portion. Highs in upper 80s and low 90s. Lows mostly in 70s.

FLORIDA EXTENDED OUTLOOK: Thursday through Saturday: Partly cloudy with widely scattered mainly afternoon thundershowers. Highs 85 to 93. Lows in the 70s.

KEYS AREAS: Partly cloudy through Wednesday with chance of showers mainly today and tonight. Low tonight upper 70s. High today and Wednesday upper 80s. Easterly winds 10 to 15 mph. Rain probability 40 per cent.

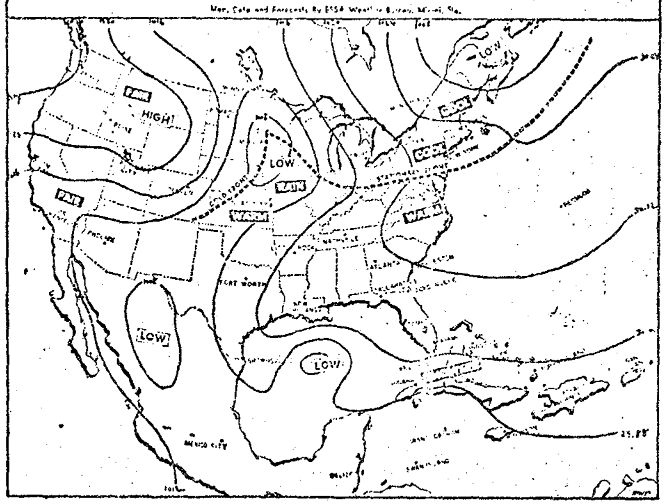
Statistics

Monday, Sept. 14, 1970	7:00 A.M.	7:00 P.M.
Barometer (inches)	30.02	30.00
Relative humidity	77%	82%
Highest temperature (past 12 hours)		86
Lowest temperature (past 18 hours)		77
Mean temperature		82
Normal temperature		82
Accumulated excess since first of month		17
Accumulated excess in temperature since Jan. 1 (degrees)		179
Highest and lowest this date since 1919		92 and 67
Local rainfall for 24 hours ending 7 p.m.		.70
Rainfall this month in inches		3.98
Rainfall deficiency this month in inches		.07
Rainfall since Jan. 1 in inches		36.34
Deficiency since Jan. 1 in inches		5.09

A nearly stationary frontal system from Central New Jersey to Central Colorado marked the boundary between Arctic and tropical air masses.

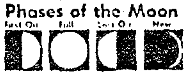
To the north of the front high temperatures held mostly to the 40s and 50s while readings in the 80s and 90s were prevalent to the south. Scattered thundershower activity occurred over the Gulf coastal region. The area west of the Rockies had generally clear skies with cool weather in the Northwest, but it remained hot in the Southwest. The national weather forecast: cloudy and showery weather will cover most of the eastern half of the nation while generally sunny weather will prevail across the West. Warming will take place from California to Idaho, Kansas and the western Dakotas.

FORECAST WEATHER MAP FOR TUES. A.M. SEPT. 15, 1970



Sunrise Today	7:06 a.m.	
Sunset Today	7:25 p.m.	
Moonrise Today	7:35 p.m.	
Moonset Wed.	8:16 a.m.	

Phases of the Moon



Oct. 7 Sept. 15 Sept. 22 Sept. 30

Local, National, World Temperatures

GREATER MIAMI

	H	L	Precip.		H	L	Precip.
Coral Gables	85	73	.06	North Miami Beach	89	72	.59
Miami Airport	85	77	.70	South Miami	89	71	1.36
Miami Beach	85	76	.05				

FLORIDA

Apalachicola	88	75	
Clewiston	85	72	
Daytona Bch.	91	79	..
Ft. Laud.	85	75	.05
Ft. Myers	84	72	.16
Gainesville	90	73	.17
Homestead	87	73	.60
Islamorada	90	79	.05
Jacksonville	85	73	.15
Key West	87	78	.01
Naples	89	69	2.77
Ocala	91	74	.05
Orlando	90	76	.61
Pensacola	92	75	..
St. Pete.	82	76	
Tallahassee	93	76	1.77
Tampa	85	75	..
Vero Beach	88	77	1.01
W. P. Bch	85	75	1.63

SOUTH

Asheville	80	56	...
Atlanta	83	65	..
Birmingham	90	65	...
Charleston	84	74	
Charlotte	90	64	..
J'son, Miss.	91	68	.
Little Rock	96	71	.
Louisville	88	69	..
Memphis	91	73	..
New Orleans	87	74	.
Raleigh	88	60	...
Richmond	90	61	...

EAST

Albany, N.Y.	54	51	.36
Boston	56	52	.03
Buffalo	62	49	.35
New York	72	65	....
Philadelphia	87	64	.
Pittsburgh	80	61	.01
Washington	89	67	

MIDWEST

Chicago	58	54	.65
Cincinnati	90	72	.02
Cleveland	64	57	.59
Columbus	60	61	.14
Des Moines	56	47	.83
Detroit	58	50	.13
Duluth	44	31	.24
Indianapolis	83	57	.29
Kansas City	72	54	.72
Milwaukee	55	53	.18
Mpls.-St. P.	50	45	.13
Omaha	52	44	1.09
St. Louis	61	59	.56

WEST

Albuquerque	85	56	..
Bismarck	43	39	.64
Brownsville	93	76	..
Denver	61	61	...
Ft. Worth	90	75	.03
Houston	89	77	...
Las Vegas	85	62	..
Los Angeles	75	64	.
Okla. City	88	70	.54
Phoenix	94	73	..
Salt L. City	61	42	.
San Antonio	95	76	...
San Diego	72	63	.
S. Francisco	—	52	...
Seattle	66	51	..

FOREIGN

City	High
Aberdeen	54
Amsterdam	69
Ankara	56
Athens	82
Auckland	55
Birmingham	75
Brussels	59
Cairo	91
Dublin	55
Lisbon	74
London	61
Madrid	75
Malta	84
Manila	82
Moscow	68
Nice	74
Oslo	56
Paris	64
Rome	81
Sofia	82
Sydney	55
Tel Aviv	84
Tokyo	75
Tunis	81
Vienna	72
Warsaw	64

PAN AMERICAN

Acapulco	86
Bermuda	82
Culiacan	86
Havana	86
Hermosillo	99
Kingston	88
Los Mochis	95
Mazatlan	88
Mexico City	73
Monterrey	81
Nassau	86
San Juan PR	90
St. Kitts	89
Vera Cruz	89

88

WEATHER OUTLOOK

Eastern Showers Break Up Nation's Fair Skies

MIAMI AND VICINITY: Decreasing showers today, becoming sunny Thursday. High 88, east and southeast winds 10 to 15 miles an hour with gusts near showers. Shower probability 50 per cent today.

SMALL BOATS: Inland waters along the southeast Florida coast including Biscayne and Florida bays — east and southeast winds 10 to 15 knots with a moderate chop on waters. Gusty winds and choppy waters near thundershowers.

FLORIDA: Scattered showers in the extreme south becoming less numerous during the day. Otherwise, widely scattered afternoon or evening thundershowers, with afternoon highs 86 to 92.

FLORIDA EXTENDED OUTLOOK: Friday through Sunday, showers and scattered thundershowers in southern Florida Friday and Saturday, improving Sunday. Elsewhere widely scattered mainly afternoon showers and thundershowers. Highs 85 to 92. Low temperatures in the 70s.

NAPLES AND LAKE OKEECHOBEE AREAS: Partly cloudy today and Thursday with afternoon and evening thundershowers likely. Low tonight mid 70s. High today and Thursday 87 to 92. Northeasterly winds 10 to 15 m.p.h. becoming southeasterly 10 to 15 m.p.h. today and Thursday. Gusty winds near thundershowers. Rain probability 60 per cent today and 30 per cent tonight.

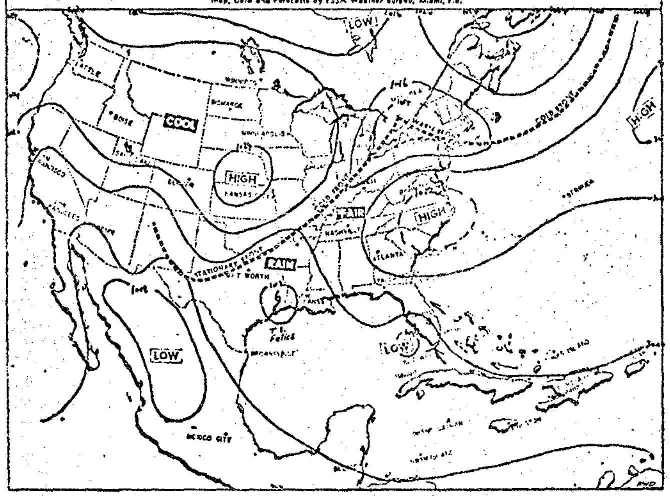
Statistics

Sept. 15, 1970	7:00 A.M.	7:00 P.M.
Barometer (inches)	29.99	29.99
Relative humidity	97 %	88 %
Highest temperature (last 12 hours)		85
Lowest temperature (past 18 hours)		76
Mean temperature		81
Normal temperature		82
Accumulated excess since first of month		16
Accumulated excess in temperature since Jan. 1 (degrees)		178
Highest and lowest this date since 1939		92 and 68
Local rainfall for 24 hours ending 7 p.m.		1.87
Rainfall this month in inches		5.85
Rainfall excess this month in inches		1.48
Rainfall since Jan. 1 in inches		38.41
Deficiency since Jan. 1 in inches		3.54

Showers and thundershowers are occurring over the entire Gulf coastal region and in the vicinity of a cold front from southeastern New Mexico and extreme southwest Texas to the upper Great Lakes. Occasional light rain or drizzle is spreading northeastward across the New England states. Meanwhile, high pressure systems are bringing generally clear skies to the area from the Dakotas and Nebraska to the Pacific states and from the Carolinas and Virginias to the Tennessee Valley. The national weather forecast: Generally sunny weather is in store for much of the nation. Scattered thundershowers are expected from the Gulf Coast through the southern Plains and lower Mississippi Valley and from the lower Missouri Valley

FORECAST WEATHER MAP FOR WED. A.M. SEPT. 16, 1970

Map, Data and Forecasts By ESSA Weather Bureau, Miami, Fla.



Sunrise Today 7:07 a.m. — Moonrise Today 8:12 p.m.

Sunset Today 7:24 a.m. — Moonset Thurs. 9:22 a.m.

Phases of the Moon

First Qtr.	Full	Last Qtr.	New
Oct. 7	Sept. 15	Sept. 22	Sept. 30

Local, National, World Temperatures

GREATER MIAMI

	H	L	Precip.
Coral Gables	84	69	3.04
Miami Airport	85	76	1.87
Miami Beach	83	73	1.88
North Miami Beach	88	71	.93
South Miami	86	71	1.77

FLORIDA

	H	L	Precip.
Apalachicola	88	78	.03
Bradenton	91	72	...
Daytona Bch.	89	78	.16
Ft. Laud.	83	70	1.47
Ft. Myers	87	75	2.98
Gainesville	88	71	.04
Homestead	85	75	.06
Islamorada	84	74	.35
Jacksonville	88	76	...
Key West	82	75	.29
Lakeland	87	74	.52
Naples	86	74	.15
Ocala	90	24	.03
Orlando	92	76	.20
Pensacola	91	75	..
Sarasota	91	72	...
St. Pete.	92	76	..
Tallahassee	92	74	.07
Tampa	90	73	.41
Vero Beach	90	75	...
W. P. Bch	86	81	.24
Asheville	85	55	...

SOUTH

	H	L	Precip.
Atlanta	83	67	...
Birmingham	89	70	...
Charleston	85	71	...
Charlotte	91	64	...
J'son, Miss.	92	72	...
Little Rock	96	66	..
Louisville	90	68	.05
Memphis	92	68	.
New Orleans	90	75	.05
Raleigh	87	62	...
Richmond	92	63	...

EAST

	H	L	Precip.
Albany, N.Y.	57	58	.70
Boston	57	52	.62
Buffalo	69	55	.12
New York	74	58	.03
Philadelphia	91	68	...
Pittsburgh	88	70	...
Washington	91	70	...

MIDWEST

	H	L	Precip.
Chicago	86	59	.23
Cincinnati	92	69	..
Cleveland	85	65	.22
Columbus	89	67	.
Des Moines	66	57	.85
Detroit	84	56	.17
Duluth	46	55	.54
Indianapolis	89	68	.
Kansas City	76	63	.95
Milwaukee	75	55	.91
Mpls-St. P.	57	49	.35
Omaha	66	47	.39
St. Louis	90	72	...

WEST

	H	L	Precip.
Albuquerque	84	51	...
Bismarck	60	40	.05
Brownsville	94	74	...
Denver	69	46	...
Ft. Worth	82	73	.
Houston	89	74	.60
Las Vegas	87	53	...
Los Angeles	79	58	...
Okla. City	92	71	...
Phoenix	97	64	...
Salt L. City	65	34	...
San Antonio	927	4	...
San Diego	74	59	...
S. Francisco	68	52	...
Seattle	63	45	...

FOREIGN

City	High
Aberdeen	55
Amsterdam	66
Ankara	86
Athens	75
Auckland	57
Berlin	75
Birmingham	57
Brussels	79
Cairo	89
Casablanca	74
Copenhagen	57
Dublin	54
Geneva	70
Lisbon	70
London	59
Madrid	75
Manila	79
Moscow	66
New Delhi	79
Nice	75
Paris	68
Rome	70
Saigon	77
Sofia	70
Stockholm	52
Sydney	54
Tel Aviv	84
Tokyo	73
Tunis	91
Vienna	75
Warsaw	56

PAN AMERICAN

Acapulco	86
Barbados	86
Bermuda	83
Culiacan	86
Havana	91
Hermosillo	95
Kingston	88
Los Mochis	99
Mazatlan	89
Mexico City	72
Monterry	86
Nassau	85
San Juan P.R.	83
St. Kitts	88
Vera Cruz	90

WEATHER OUTLOOK

Fair Weather Likely For East, West Coasts

MIAMI AND VICINITY: Sunny today and Friday. High 88. Easterly winds 10 to 15 miles an hour. Shower probability 30 per cent during morning hours today.

SMALL BOATS: Inland waters along the southeast Florida coast including Biscayne and Florida bays — easterly winds 10 to 15 knots with a moderate chop on the waters.

FLORIDA: Partly cloudy today with a chance of a few morning showers along the east coast and Keys.

FLORIDA EXTENDED OUTLOOK: Saturday through Monday — Partly cloudy with scattered afternoon thundershowers mainly in the interior and Western portions of the state and a few showers along the East coast and Keys. Afternoon highs near 90. Lows mainly in the 70's.

LAKE OKEECHOBEE AND INDIAN RIVER — BREVARD AREAS: Partly cloudy through Friday with a chance of afternoon showers. Lows in the 70's. Highs near 90. Easterly winds 15 m.p.h. gusty near thundershowers decreasing inland. Rain probability 30 per cent.

BROWARD — PALM BEACH AND KEYS AREAS: Partly cloudy through Friday with a chance of showers mainly during the night and morning hours. Afternoon highs near 90. Lows 75 to 80. Easterly winds 15 m.p.h. gusty near showers. Rain probability 50 per cent.

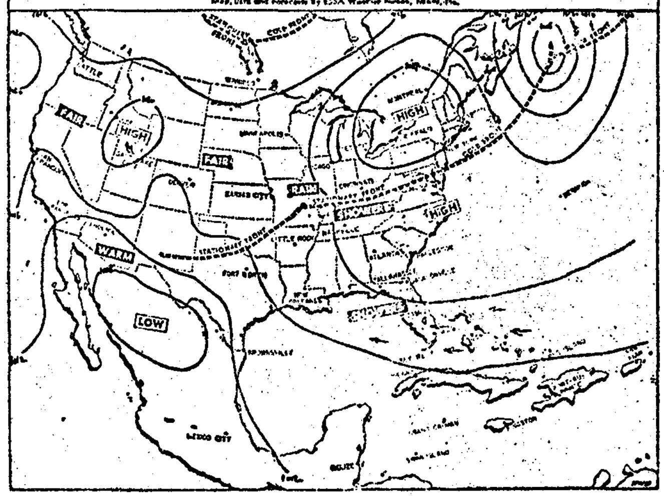
Statistics

Wednesday, Sept. 15, 1970	7:00 A.M.	7:00 P.M.
Barometer (inches)	30.05	30.05
Relative humidity	91 %	88 %
Highest temperature (past 12 hours)		88
Lowest temperature (past 18 hours)		78
Mean temperature		83
Normal temperature		82
Accumulated excess since first of month		17
Accumulated excess in temperature since Jan. 1 (degrees)		179
Highest and lowest this date since 1939		91 and 70
Local rainfall for 24 hours ending 7 p.m.		.07
Rainfall this month in inches		8.92
Rainfall excess this month in inches		1.23
Rainfall since Jan. 1 in inches		38.48
Deficiency since Jan. 1 in inches		3.79

Showers and locally heavy thunderstorms are occurring from Louisiana and southeastern New Mexico to South Dakota and extreme southern Minnesota and from the central Gulf to Florida and southern Georgia. The only other precipitation in the nation was some light rain or drizzle moving eastward from Maine and some light rain spreading to the Washington coast. The skies are generally clear from eastern Montana and western New Mexico to California. The national weather forecast: Generally sunny weather is in prospect for much of the nation. Cloudy and showery weather is likely in the Mississippi Valley, the lower Ohio Valley and the upper Great Lakes region.

FORECAST WEATHER MAP FOR THURS. A.M. SEPT. 17, 1970

Map, Data and Forecasts By ESSA Weather Bureau, Miami, Fla.



Sunrise Today 7:07 a.m.
Sunset Today 7:23 p.m.

Phases of the Moon
First Qu. Full Last Qu. New
Oct. 7 Sept. 15 Sept. 22 Sept. 30

Moonrise Today 8:50 p.m.
Moonset Friday 9:28 a.m.

Local, National, World Temperatures

GREATER MIAMI

	H	L	Precip.		H	L	Precip.
Coral Gables	86	75	.04	Miami Beach	83	73	1.98
Miami Airport	88	78	.07	North Miami Beach	91	75	.07
Miami Beach	85	77	.02	South Miami	90	73	...

FLORIDA

Apalachicola	87	75	...
Bradenton	95	75	.71
Clewiston	91	74	..
Daytona Bch.	90	78	.56
Ft. Laud.	88	77	.07
Ft. Myers	90	74	.67
Gainesville	92	75	...
Homestead	88	72	.19
Jacksonville	70	76	...
Key West	88	78	.01
Lakeland	88	74	.
Naples	91	72	.75
Ocala	95	74	...
Orlando	92	77	.05
Pensacola	89	77	.09
Sarasota	95	75	.71
St. Pete.	92	78	..
Tallahassee	88	73	.06
Tampa	90	75	...
Vero Beach	91	81	...
W. P. Bch.	88	77	...

SOUTH

Asheville	87	56	...
Atlanta	88	67	...
Birmingham	90	71	...
Charleston	88	76	...
Charlotte	89	64	...
J'son, Miss.	91	76	..
Little Rock	95	73	.06
Louisville	89	64	..
Memphis	91	73	
New Orleans	88	73	1.05
Norfolk	89	67	...
Richmond	95	63	...

EAST

Albany, N.Y.	73	55	...
Boston	89	53	...
Buffalo	71	64	...
New York	92	61	...
Philadelphia	93	67	...
Pittsburgh	87	47	...
Washington	94	70	...

MIDWEST

Chicago	60	55	...
Cincinnati	93	65	...
Cleveland	66	58	...
Columbus	82	64	...
Des Moines	61	52	...
Detroit	72	60	...
Duluth	63	37	...
Indianapolis	83	63	...
Kansas City	68	61	...
Milwaukee	60	50	...
Mpls.-St. P.	61	40	..
Omaha	54	49	.13
St. Louis	81	64	...

WEST

Bismarck	67	32	...
Brownsville	94	74	...
Denver	77	45	..
Houston	89	74	.26
Las Vegas	88	55	...
Los Angeles	85	61	.
Okla. City	80	63	.73
Phoenix	97	64	...
Salt L. City	70	38	.
San Antonio	92	77	.83
San Diego	78	65	...
S. Francisco	71	52	...
Seattle	71	52	...

FOREIGN

CITY	HIGH
Aberdeen	57
Ankara	77
Athens	83
Auckland	75
Berlin	64
Birmingham	59
Cairo	86
Copenhagen	61
Hong Kong	81
Malta	84
Manila	81
Moscow	72
Nice	81
Oslo	55
Paris	61
Rome	79
Sofia	79
Stockholm	62
Sydney	57
Tel Aviv	86
Tokyo	72
Tunis	88
Vienna	68
Warsaw	77

PAN AMERICAN

Acapulco	90
Barbados	89
Bermuda	84
Culiacan	86
Havana	96
Hermosillo	93
Kingston	88
Los Mochis	82
Mazatlan	90
Mexico City	75
Monterrey	88
Nassau	86
San Juan	88
St. Kitts	86
Vera Cruz	88

WEATHER OUTLOOK

Unseasonal Warmth Moving Toward Midwest

MIAMI AND VICINITY: Showers are likely today. High in the upper 80s. Low tonight upper 70s. Sunny Tuesday. Easterly winds 10-15 miles an hour. Shower probability 60 per cent.

FLORIDA: Partly cloudy with widely scattered thundershowers mainly in the afternoon and evening hours in the interior and on the West Coast with a few brief night and morning showers along the East Coast. Increasing showers and thundershowers in the extreme south in the morning. High 88-93. Low in the 70s.

SMALL BOATS: Inland waters — East and southeast winds 10-15 knots with a moderate chop on the waters. Gusty winds and choppy waters near a few heavier showers and thundershowers.

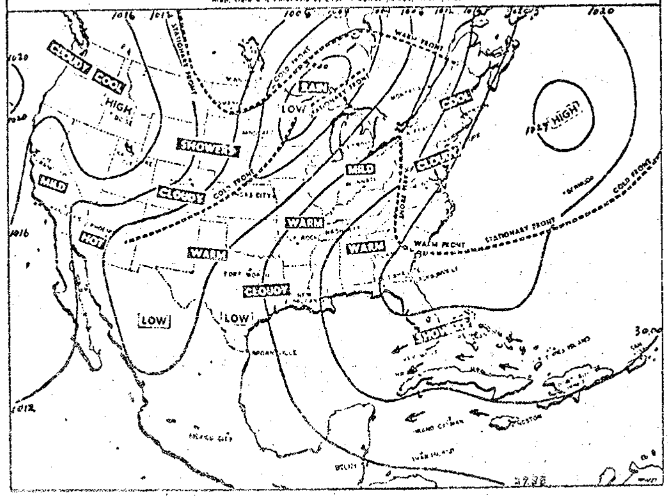
FLORIDA EXTENDED OUTLOOK: Wednesday through Friday: Continued warm with a few scattered showers along southeast coast and Keys areas. Afternoon thundershowers will prevail elsewhere throughout the state. Afternoon highs in the upper 80s and low 90s will be common. Late night and early morning lows will be in the 70s.

Statistics

September 20, 1970	7:00 A.M.	7:00 P.M.
Barometer (inches)	30.02	30.00
Relative humidity	97%	55%
Highest temperature (last 12 hours)		87
Lowest temperature (past 18 hours)		78
Mean temperature		83
Normal temperature		81
Accumulated excess since first of month		20
Accumulated excess in temperature since Jan. 1 (degrees)		182
Highest and lowest this date since 1939		92 and 70
Local rainfall for 24 hours ending 7 p.m.		.04
Rainfall this month in inches		6.76
Rainfall excess this month in inches		.76
Rainfall since Jan. 1 in inches		39.32
Deficiency since Jan. 1 in inches		4.28

Above-normal warmth for late September is being transported by southerly winds from the South to the Great Lakes. Afternoon readings neared the 90-degree mark. But in contrast to most of the country, cool and showery weather continued in the Northwest. The cool push is preceded by a storm center spinning northeast across the Dakotas, and accompanied by locally severe thunderstorms. The national forecast: Mostly sunny and warm weather will prevail with widely scattered thundershower activity. Thundershowers are likely by afternoon in the Rockies and also from the Gulf states to the Great Lakes. Warming is forecast for the mid-Atlantic states and California.

FORECAST WEATHER MAP FOR MON. A.M. SEPT. 21, 1970



Sunrise Today 7:09 a.m.
Sunset Today 7:19 p.m.

Phases of the Moon

First Qu. Oct. 7 · Full Sept. 15 · Last Qu. Sept. 22 · New Sept. 30

Moonrise Today Midnight
Moonset Tues. 2:31 p.m.

Local, National, World Temperatures

GREATER MIAMI

	H	L	Precip.
Coral Gables	86	75	
Miami Airport	87	78	.04
Miami Beach	84	80	...
Miami Bay Frnt Prk	86	77	
North Miami Beach	89	73	.73
South Miami	86	73	.06

FLORIDA

	H	L	Precip.
Apalachicola	89	76	..
Clewiston	91	75	..
Daytona Bch.	90	75	.02
Ft. Laud.	89	74	.15
Ft. Myers	92	75	.15
Gainesville	92	70	...
Islamorada	88	79	...
Jacksonville	90	72	..
Key West	85	78	.10
Lakeland	89	74	...
Naples	92	74	1.17
Ocala	95	74	...
Orlando	94	76	...
Pensacola	91	79	..
St. Pete.	93	77	..
Tallahassee	93	72	...
Tampa	92	73	..
Vero Beach	91	76	..
W. P. Bch.	87	75	.12

SOUTH

	H	L	Precip.
Asheville	77	46	...
Atlanta	91	71	..
Birmingham	94	70	..
Charleston	86	78	.10
Charlotte	80	68	.
J'son, Miss.	89	73	...
Louisville	68	67	...
New Orleans	91	74	...
Raleigh	82	56	...
Richmond	63	56	...

EAST

	H	L	Precip.
Albany, N.Y.	77	42	...
Baltimore	82	49	...
Boston	77	55	...
Buffalo	71	53	...
New York	79	59	...
Philadelphia	80	55	...
Pittsburgh	84	47	...
Washington	81	61	...

MIDWEST

	H	L	Precip.
Chicago	85	67	...
Cincinnati	89	66	...
Cleveland	81	55	...
Columbus	83	56	...
Des Moines	91	64	...
Detroit	80	53	...
Duluth	85	65	...
Indianapolis	73	62	...
Kansas City	92	73	...
Milwaukee	52	58	...
Mpls. St. P.	79	67	.01
Omaha	91	67	...
St. Louis	89	66	...

WEST

	H	L	Precip.
Albuquerque	88	59	.06
Bismarck	73	51	
Brownsville	91	76	1.11
Denver	87	47	...
Ft. Worth.	91	75	...
Honolulu	87	71	...
Houston	86	77	...
Las Vegas	87	47	...
Los Angeles	82	64	...
Okla. City	90	71	...
Phoenix	96	67	...
Salt L. City	64	46	.14
San Antonio	92	73	.05
San Diego	72	61	...
S. Francisco	64	52	..
Seattle	59	53	.20

FOREIGN

City	High
Aberdeen	59
Amsterdam	70
Athens	82
Berlin	68
Birmingham	72
Brussels	70
Cairo	91
Casablanca	91
Copenhagen	59
Dublin	64
Geneva	69
Hong Kong	85
Lisbon	81
London	73
Madrid	84
Malta	77
Manila	81
Moscow	68
New Delhi	93
Nice	77
Oslo	57
Rome	81
Saigon	82
Stockholm	63
Sydney	52
Tel Aviv	86
Tokyo	73
Tunis	75
Vienna	78
Warsaw	63

PAN AMERICAN

Acapulco	86
Barbados	86
Bermuda	82
Bogota	66
Culiacan	91
Havana	86
Hermosillo	100
Kingston	90
Los Mochis	95
Mazatlan	88
Mexico City	73
Monterrey	91
San Juan PR	88
St Kitts	88
Vera Cruz	86

WEATHER OUTLOOK

Storms Bring Hail and Rain to Nation's Center

MIAMI AND VICINITY: Low early today in mid 70s. Occasional thunder-showers mainly during the night and morning hours through Wednesday. High today upper 80s. East and southeast winds 10 to 15 m.p.h. gusty near thunder-showers. Shower probability 50 per cent during the night and morning hours, otherwise 20 per cent.

FLORIDA: Partly cloudy with widely scattered showers, mainly during the afternoon and evening hours. High 87-94.

INLAND WATERS: Will have a moderate chop, becoming choppy near heavier showers. Keys southward through the Florida Straits — east and southeast winds 10-15 knots with seas 2-4 feet.

FLORIDA EXTENDED OUTLOOK: Thursday through Saturday — Continued warm with widely scattered afternoon and evening showers. Highs 87 to 93. Lows 70 to 74.

LAKE OKEECHOBEE AND NAPLES AREAS: Partly cloudy through Wednesday with thundershowers likely mainly during the afternoon hours. Highs 88 to 93. Lows in the 70s. Easterly winds 10 to occasionally 15 m.p.h. gusty near showers and decreasing at night. Rain probability 60 per cent.

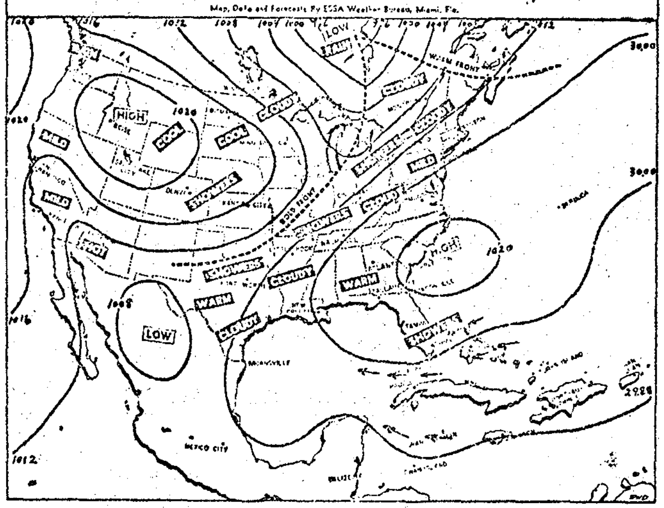
Statistics

Sept. 21, 1970	7:00 A.M.	7:00 P.M.
Barometer (inches)	30.01	29.93
Relative humidity	85%	82%
Highest temperature (last 12 hours)		86
Lowest temperature (past 18 hours)		74
Mean temperature		80
Normal temperature		81
Accumulated excess since first of month		19
Accumulated excess in temperature since Jan. 1 (degrees)		181
Highest and lowest this date since 1937		92 and 70
Local rainfall for 24 hours ending 7 p.m.		.36
Rainfall this month in inches		7.12
Rainfall excess this month in inches		.76
Rainfall since Jan. 1 in inches		39.68
Deficiency since Jan. 1 in inches		2.92

Thunderstorms are rumbling across the central part of the nation producing strong winds, hail and heavy rain. The activity is in the area of an advancing cold front which is displacing unseasonably warm air along its path and is followed by a cooler and less humid mass of air. Baseball-sized hail and rainfall were reported near Berrytown, Kan. about 10 miles south of Topeka Monday. Cool weather prevails in the Northwest and across the North and Central Rockies to the adjoining Plains. A few snow flurries have been noted at higher mountain elevations. Widely scattered late summer thundershowers redeveloped in a broad tropical flow from the humid Southeast to the Eastern Great Lakes area.

FORECAST WEATHER MAP FOR TUES. A.M. SEPT. 22, 1970

Map, Data and Forecasts By ESSA Weather Bureau, Miami, Fla.



Sunrise Today 7:09 a.m. Sunset Today 7:17 p.m.

Phases of the Moon

Oct. 7 Sept. 15 Sept. 22 Sept. 30

Moonrise Today 12:55 a.m. Moonset Today 2:31 p.m.

Local, National, World Temperatures

GREATER MIAMI

	H	L	Precip.
Coral Gables	87	72	.21
Miami Airport	86	74	.36
Miami Beach	84	73	.34
North Miami Beach	90	71	.23
South Miami	89	69	.80

FLORIDA

Apalachicola	88	81	...
Clewiston	87	72	.67
Daytona Bch.	89	75	.03
Ft. Laud.	88	73	.22
Ft. Myers	91	73	...
Gainesville	92	71	
Homestead	83	70	.85
Islamorada	86	74	.64
Jacksonville	90	73	
Key West	86	75	.77
Ocala	95	73	..
Orlando	82	77	.07
Pensacola	92	70	...
St. Pete.	92	78	...
Tallahassee	92	68	...
Tampa	91	72	.05
Vero Beach	90	74	
W. P. Bch.	85	80	.24

SOUTH

Asheville	86	65	.08
Atlanta	87	73	.31
Birmingham	94	70	..
Charleston	86	73	
Charlotte	90	65	.06
J'son, Miss.	92	70	...
Little Rock	94	72	..
Louisville	91	69	.31
Memphis	93	77	...
New Orleans	92	71	...
Raleigh	87	64	...
Richmond	92	62	...

EAST

Albany, N.Y.	81	52	..
Bermuda	82	76	.11
Boston	81	60	..
Buffalo	82	67	...
New York	82	64	...
Philadelphia	86	62	..
Pittsburgh	87	62	...
Washington	88	66	...

MIDWEST

Chicago	89	74	...
Cincinnati	94	72	.09
Cleveland	87	67	...
Columbus	91	67	...
Des Moines	62	71	.25
Detroit	91	65	...
Duluth	70	63	.24
Indianapolis	90	70	...
Kansas City	87	74	..
Milwaukee	85	72	.05
Mpls.-St. P.	71	65	.08
Omaha	73	65	.81
St. Louis	93	74	...

WEST

Albuquerque	85	56	...
Bismarck	64	48	...
Brownsville	92	78	
Denver	67	41	.01
Ft. Worth	90	77	..
Houston	89	77	.59
Las Vegas	87	59	...
Los Angeles	79	62	...
Okla. City	87	73	..
Phoenix	95	65	..
Salt L. City	60	46	.03
San Antonio	93	76	...
San Diego	71	62	...
S. Francisco	74	53	..
Seattle	59	48	...

FOREIGN

City	High
Aberdeen	55
Amsterdam	66
Ankara	82
Athens	79
Berlin	63
Birmingham	63
Brussels	68
Cairo	95
Casablanca	82
Copenhagen	57
Dublin	61
Geneva	78
Hong Kong	81
Lisbon	86
London	70
Madrid	86
Malta	77
Manila	82
Moscow	82
Nice	77
Oslo	59
Paris	77
Rome	86
Saigon	82
Sofia	61
Stockholm	54
Sydney	63
Tel Aviv	86
Tokyo	72
Tunis	79
Vienna	64
Warsaw	63

PAN AMERICAN

City	High
Acapulco	86
Barbados	88
Bermuda	82
Culiacan	90
Havana	88
Hermosillo	99
Los Mochis	91
Mazatlan	88
Mexico City	75
Monterrey	90
Nassau	86
San Juan P.R.	88
St. Kitts	88
Vera Cruz	86

WEATHER OUTLOOK

Summer '70 Bows Out With Weather Potpourri

MIAMI AND VICINITY: Sunny today and Thursday with a few mainly night and morning showers. High in the upper-80s. East and southeast winds 10-15 m.ph. Shower probability 40 per cent.

SMALL BOATS: Atlantic coastal waters — east and southeast winds 10-15 knots with seas 2-3 feet. Winds and seas locally higher near heavy showers and thundershowers. Inland waters along the Southeast Florida coast including Biscayne and Florida Bays — east and southeast winds 10-15 knots with a light to moderate chop on the waters. Gusty winds and choppy waters near heavier showers and thundershowers.

KEYS AREAS: Partly cloudy through Thursday with a chance of showers. Low tonight in the mid to upper 70s. Afternoon highs mid to upper 80s. East and southeast winds 10 to 15 m.p.h. Rain probability 40 per cent.

FLORIDA: Partly cloudy today with widely scattered thundershowers in Keys and with widely scattered mainly afternoon and evening thundershowers elsewhere. Highs 87-94. Lows tonight in 70s.

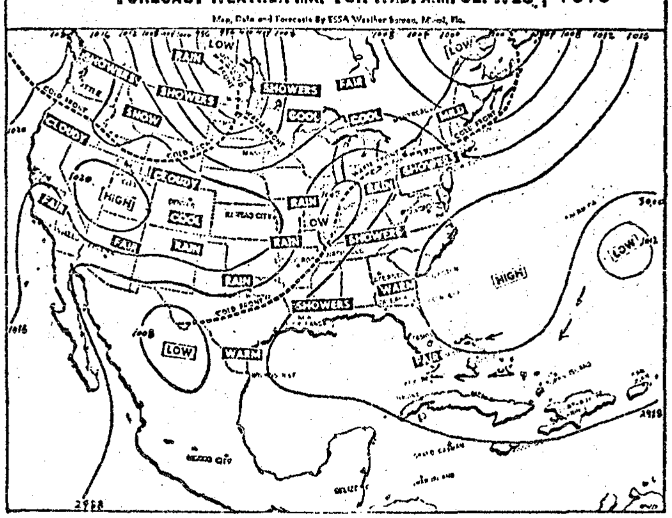
FLORIDA EXTENDED OUTLOOK: Friday through Sunday, widely scattered mainly afternoon and evening thundershowers with a few night and morning showers along the east coast and keys. Afternoon highs in the upper 80s and low 90s. Overnight lows mostly in the 70s.

Statistics

Tuesday, Sept. 22, 1970	7:00 A.M.	7:00 P.M.
Barometer (inches)	29.93	29.95
Relative humidity	97 %	75 %
Highest temperature (past 12 hours)		86
Lowest temperature (past 18 hours)		75
Mean temperature		81
Normal temperature		83
Accumulated excess since first of month		19
Accumulated excess in temperature since Jan. 1 (degrees)		183
Highest and lowest this date since 1939		91 and 70
Local rainfall for 24 hours ending 7 p.m.		0
Rainfall this month in inches		7.12
Rainfall excess this month in inches		4.21
Rainfall since Jan. 1 in inches		39.68
Deficiency since Jan. 1 in inches		4.60

Widespread unpleasant weather covered the nation as summer drew to a close. Eastward from the Great Lakes to Texas, showers and thundershowers were scattered. Pea-sized hail pelted Bartow, Fla., and in eastern Missouri and Oklahoma flash flooding was possible in a few streams because of heavy rains. The national weather forecast: fair skies will rule eastward from the Gulf Coast to New England although thundershowers will be scattered in all but the middle Atlantic coast states. Partly cloudy skies and warmer weather will prevail from the upper Mississippi Valley to the Southwest. However, cooler weather will occur in the remainder of the country with showers common from the Great Lakes to Texas.

FORECAST WEATHER MAP FOR WED. A.M. SEPT. 23, 1970



Sunrise Today 7:10 a.m.
Sunset Today 7:16 p.m.

Phases of the Moon
First Qtr. Full Last Qtr. New
Oct. 7 Oct. 14 Oct. 21 Sept. 30

Moonrise Thurs. 1:53 a.m.
Moonset Thurs. 4:00 p.m.

Local, National, World Temperatures

GREATER MIAMI

	H	L	Precip.
Coral Gables	87	71	.21
Miami Airport	86	75	...
Miami Beach	85	73	.20
North Miami Beach	91	75	.23
South Miami	88	76	...

FLORIDA

	H	L	Precip.
Apalachicola	87	75	...
Bradenton	88	73	..
Clewiston	89	72	.02
Daytona Bch.	89	74	..
Ft. Laud.	89	79	.09
Ft. Myers	92	73	.10
Gainesville	91	70	..
Homestead	88	71	.41
Islamorada	91	75	.05
Jacksonville	90	72	.10
Key West	84	77	...
Lakeland	89	73	.tr
Naples	90	71	.47
Ocala	95	73	.03
Orlando	94	75	...
Pensacola	91	77	.tr
Sarasota	94	73	...
St. Pete.	92	77	..
Tallahassee	91	73	.10
Tampa	91	73	.tr
Vero Beach	90	75	.69
W. P. Bch.	88	80	.69

SOUTH

	H	L	Precip.
Asheville	86	64	...
Atlanta	87	69	...
Birmingham	92	68	..
Charleston	88	65	...
Charlotte	91	68	...
J'son, Miss.	92	70	...
Little Rock	95	70	..
Louisville	90	70	.03
Memphis	94	73	..
New Orleans	90	70	.29
Raleigh	91	67	...
Richmond	95	68	...

EAST

	H	L	Precip.
Albany, N.Y.	91	28	...
Boston	91	66	...
Buffalo	82	72	...
New York	94	72	...
Philadelphia	94	70	...
Pittsburgh	89	72	...
Washington	95	71	...

MIDWEST

	H	L	Precip.
Chicago	69	61	1.06
Cincinnati	93	73	...
Cleveland	86	70	.20
Columbus	90	71	..
Des Moines	67	59	.85
Detroit	81	70	...
Duluth	61	49	...
Indianapolis	89	70	...
Kansas City	61	59	6.33
Milwaukee	68	61	.12
Mpls.-St. P.	63	51	...
Omaha	64	52	...
St. Louis	78	68	.51

WEST

	H	L	Precip.
Albuquerque	65	52	...
Bismarck	69	41	...
Brownsville	92	77	
Denver	57	37	1.38
Houston	90	78	.01
Las Vegas	82	60	..
Los Angeles	93	64	..
Okla. City	74	61	6.25
Phoenix	91	66	.
Salt L. City	64	36	...
San Antonio	94	77	...
SanDiego	81	60	...
S. Francisco	85	64	
Seattle	64	54	.04

FOREIGN

City	Temp
Aberdeen	54
Amsterdam	59
Athens	75
Auckland	48
Berlin	61
Birmingham	61
Brussels	61
Casablanca	77
Copenhagen	59
Dublin	63
Geneva	73
Hong Kong	88
Lisbon	79
London	61
Madrid	86
Malta	81
Manila	82
Moscow	46
New Delhi	91
Nice	75
Oslo	57
Paris	73
Rome	82
Saigon	75
Stockholm	52
Sydney	64
Vienna	61
Warsaw	55

PAN AMERICAN

Acapulco	82
Barbados	88
Bermuda	83
Bogota	59
Culiacan	86
Havana	88
Hermosillo	95
Kingston	88
Los Mochis	91
Mazatlan	86
Mexico City	73
Monterrey	86
Nassau	90
SanJuan PR	89
St Kitts	87
Vera Cruz	84

APPENDIX C. AUTO- AND CROSS-CORRELATION INVESTIGATIONS OF THE DATA FROM 22 SEPTEMBER 1970

(Attachment III of final report on contract DAAG39-70-0053, 17 Feb. 1971.)

The data presented here were obtained from a limited analysis of the magnetic-tape records of the experiments on 22 September. They are believed to be representative of the general behavior of all the data recorded. They should be considered as guides to the direction which future, more detailed, analysis should take.

The auto- and cross-correlation plots shown in Figures III-1 through III-5 were made by re-playing the magnetic tape of the indicated data runs into a Fabri-Tek Model 1072 Signal Averager configured for computing such functions. Due to the design of the Model 1072, the resulting plots are only approximately normalized for signal distributions such as considered here; thus, care must be exercised in interpreting the value of the coefficients of the correlation functions obtained.

The correlation functions were computed and plotted for each frequency at each range point. These were reviewed for calibration difficulties, noise and hum problems, and reproducibility. The examples shown in Figures III-1 through III-5 were chosen as being representative and illustrative of the general conclusions about the correlation properties of these data runs on 22 September. These general conclusions are as follows. (1) The received signals are approximately periodic and have periods of 2 to 3 seconds, although there are other competing periodic components, principally a component with period between 6 and 7 seconds. (2) The fluctuations of received signals at any two frequencies are virtually uncorrelated. (3) The recorded samples are obtained from a process that is only approximately statistically stationary.

Except for III-3 and III-5b, the plots were all made with a dwell time of 40 milliseconds using 256 channels, which resulted in an approximate sweep duration of 10 seconds. The amplitude and d-c level of the input signals were adjusted to minimize overflow problems in the A/D converter of the Model 1072. The noise reference was adjusted to have approximately the same rms value as the corresponding data record. The square-wave reference was adjusted to have a peak amplitude approximately equal to the "average of the peaks" of the corresponding data record.

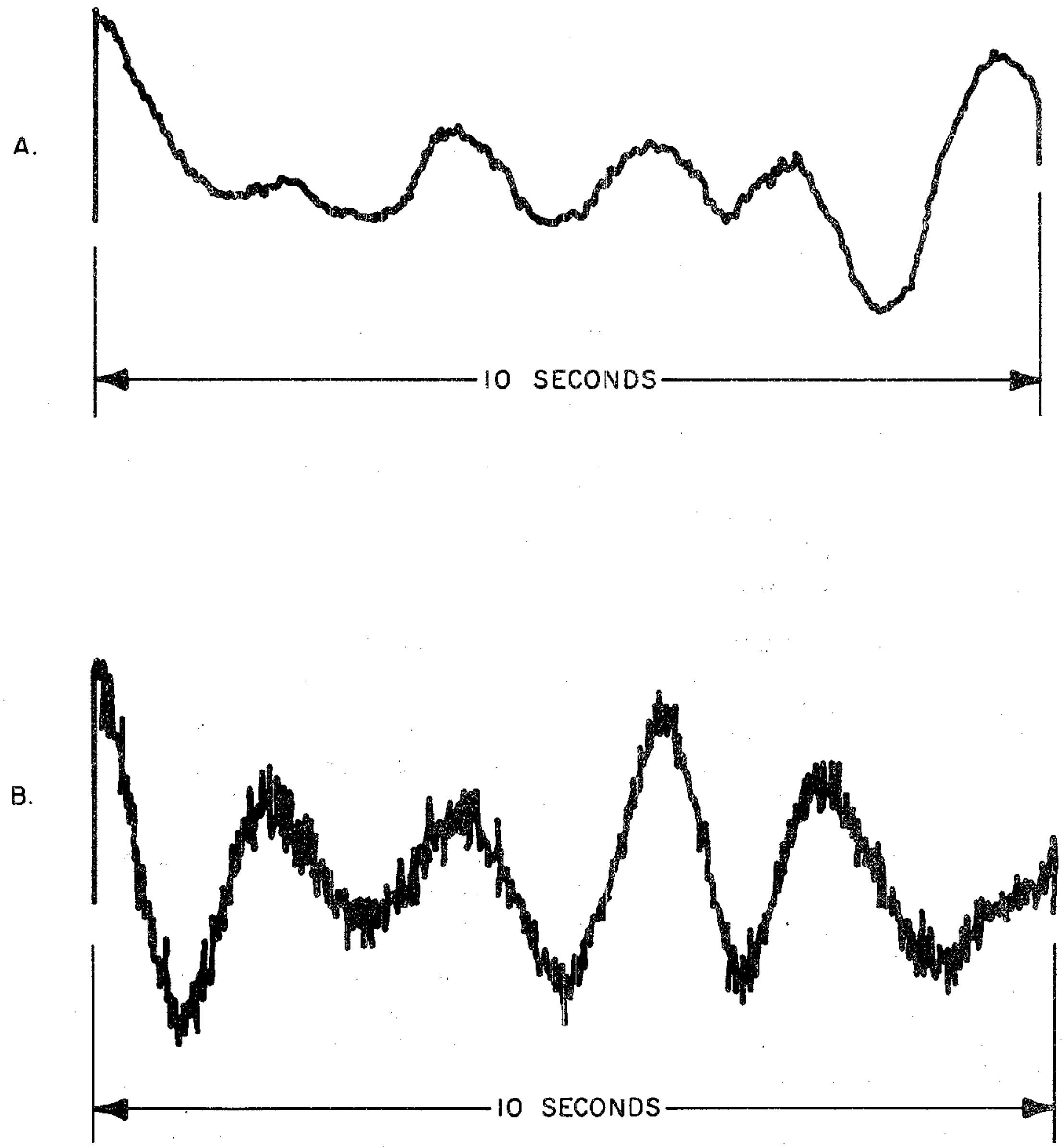


Figure III-1. Comparison between auto-correlation plots for (A) a noise signal (Gaussian, 0.5 Hz bandwidth filter) and (B) the received signal on 30 MHz (Run 2, 22 September.)

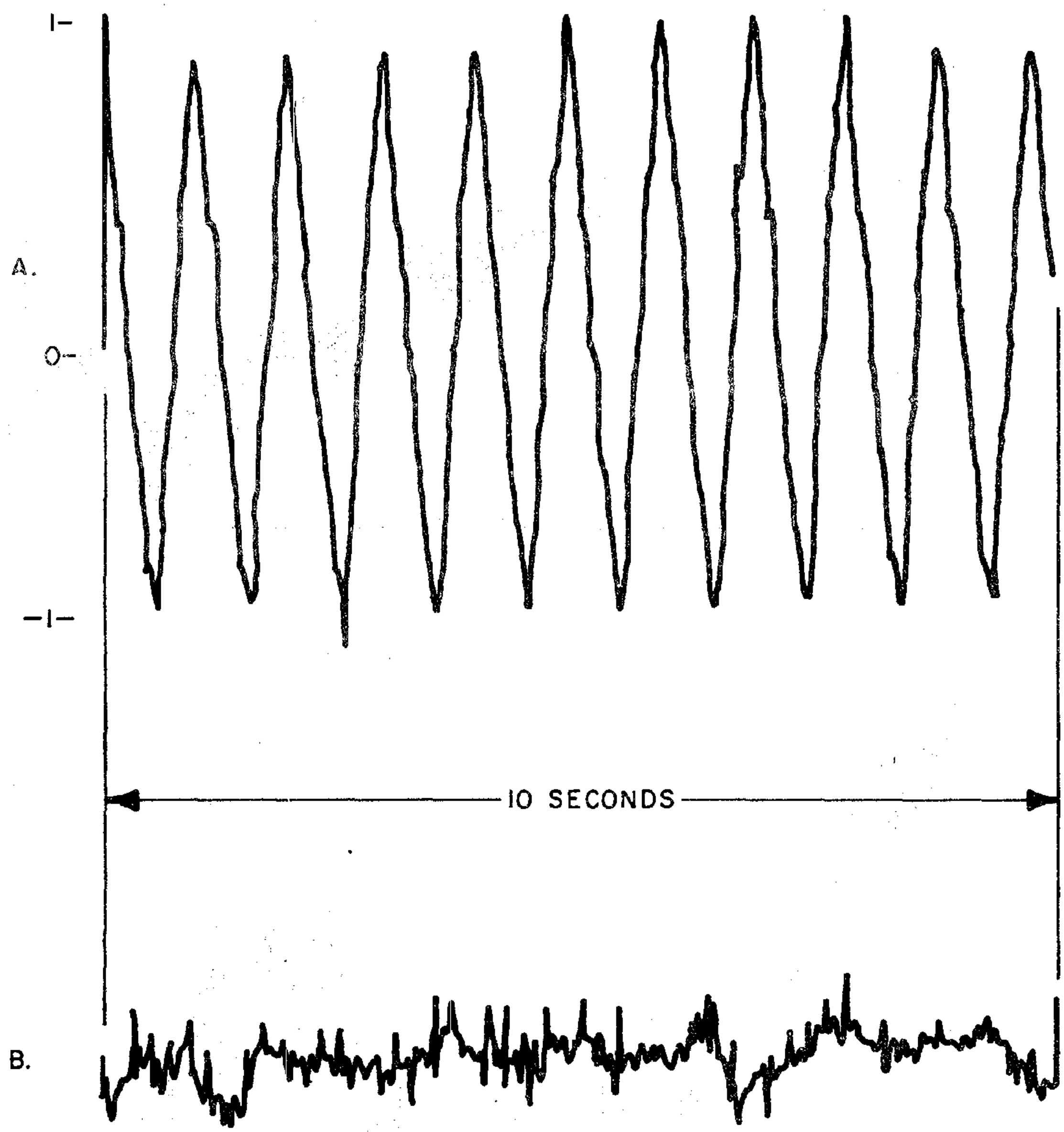


Figure III-2. Comparison between cross-correlation plots for (A) a square-wave signal (1 Hz period) and (B) the product of the received signals on 412 and 140 MHz (Run 2, 22 September.)

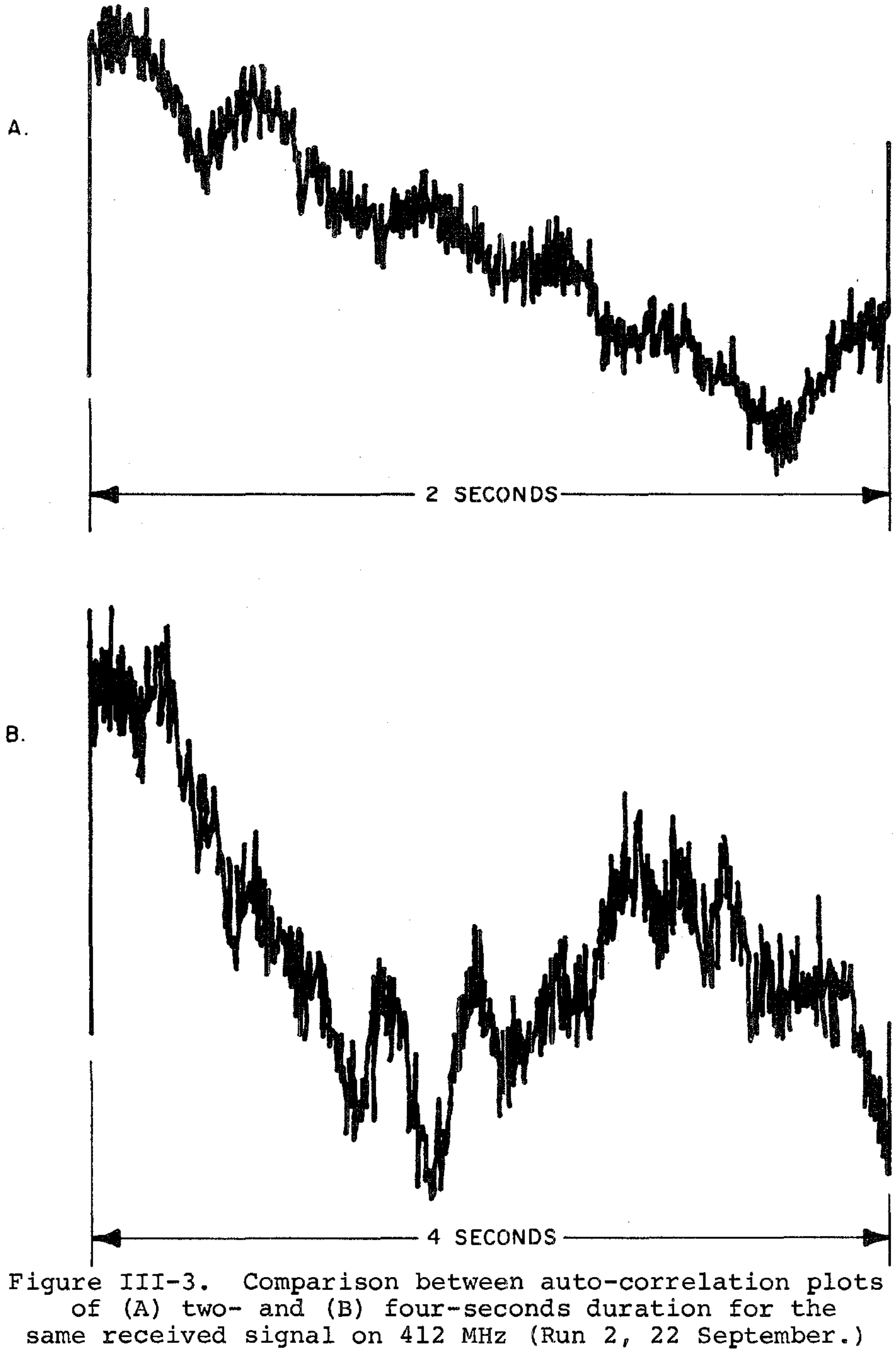


Figure III-3. Comparison between auto-correlation plots of (A) two- and (B) four-seconds duration for the same received signal on 412 MHz (Run 2, 22 September.)

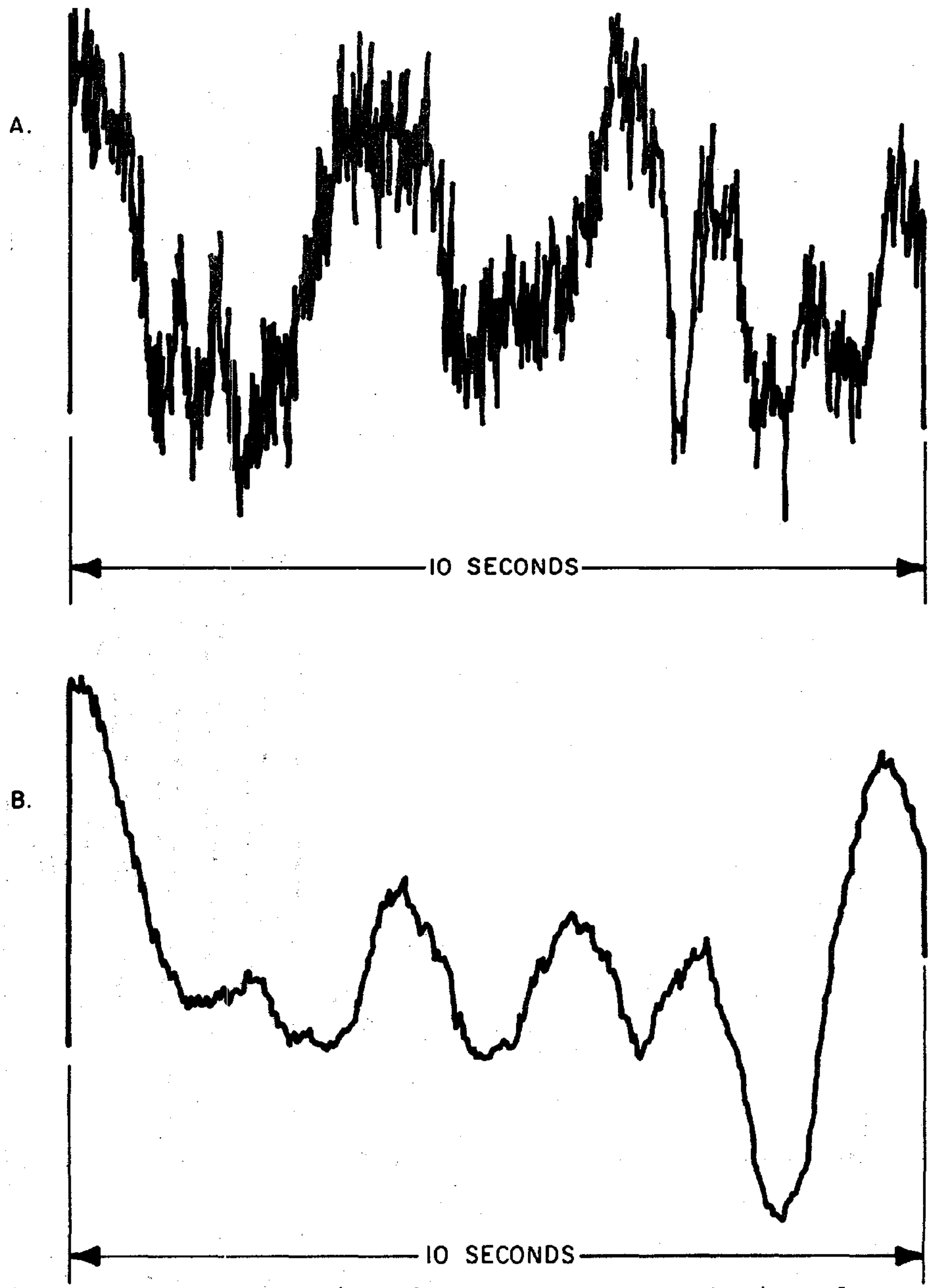
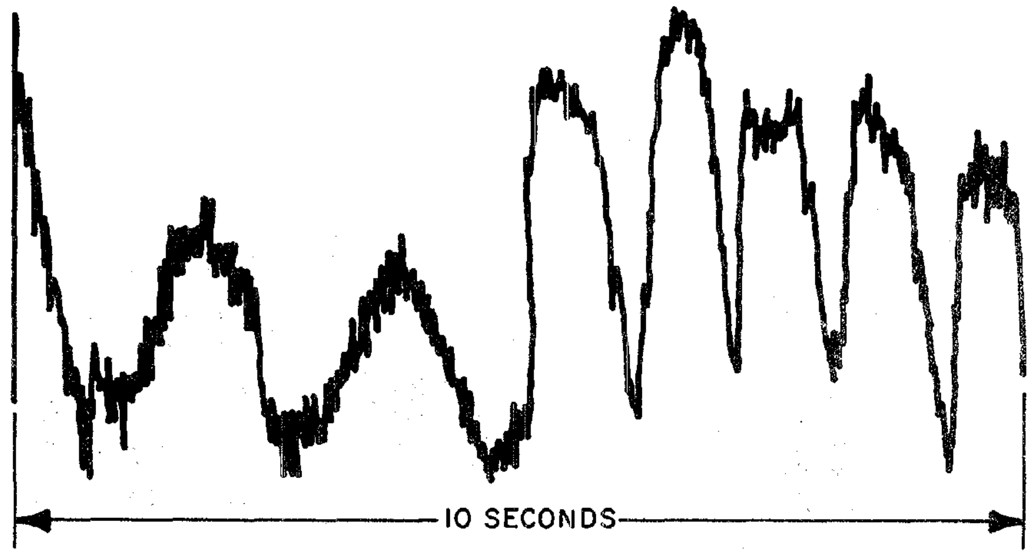


Figure III-4. Comparison between auto-correlation plots of (A) the received signal on 412 MHz (Run 2, 22 September) and (B) a noise signal (Gaussian, 0.5 Hz bandwidth filter).

A.



B.

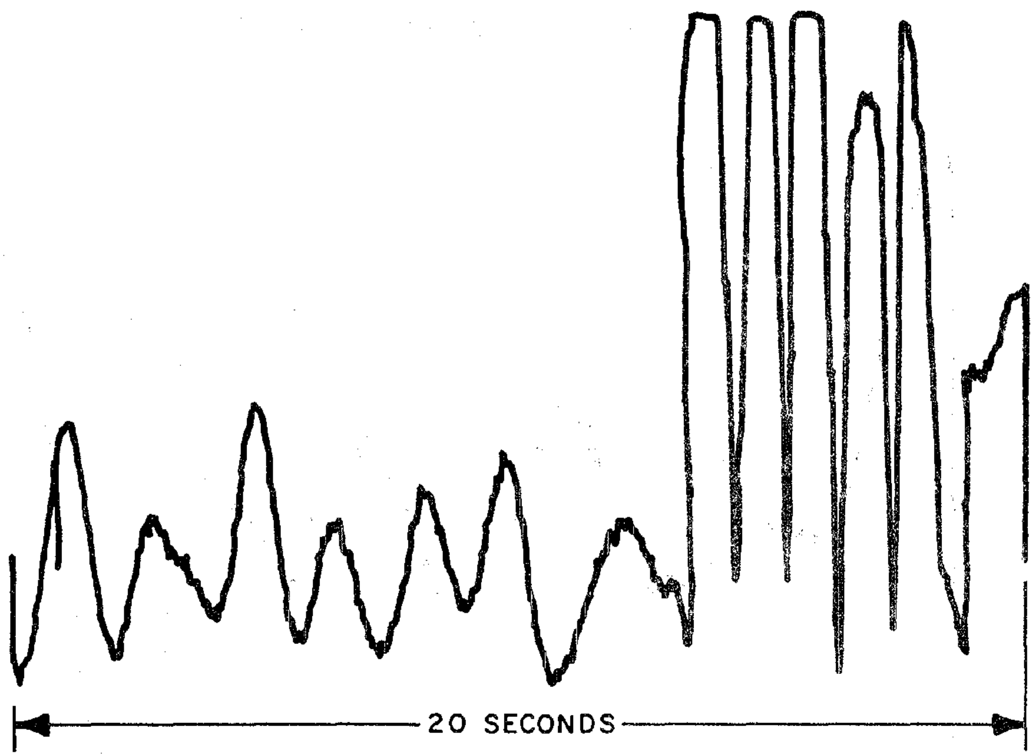


Figure III-5. Comparison between the auto-correlation plot of (A) the complete record of the received signal on 30 MHz for Run 2 (22 September) and (B) the smoothed time history of the received signal.

Sixteen sweeps of 10 seconds each were overlaid for each plot; since most of the samples on the magnetic tape are of one-minute duration, this required several passes of the tape. The only problem encountered with this overlaying process was that the tape-transients prevented the stripping of the d-c component with high-pass filters; such stripping would have provided a more accurate zero reference for the plots. This problem was not resolved due to the limited amount of time available for this analysis.

Figure III-3 and III-4 are included to illustrate the similarity between the auto-correlation functions of the signals at different frequencies (compare with Figure III-1), and also to demonstrate the reproducibility of some of the data records.

Figure III-5 illustrates a data run which exhibited rather different behavior near the end of the sample period for which no explanation has been found. The auto-correlation plot of Figure III-5A was made from the complete data record for that run and includes the last ten seconds of data which exhibit the unusual behavior. Figure III-5B shows a smoothed time history of this portion of the record. Figure III-1B shows the results obtained when the unusual signal is deleted.